REPORT R-1669

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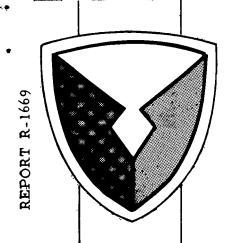
FRANKFORD ARSENAL

COMPUTER ANALYSIS & LABORATORY EVALUATION
OF INTERACTION EFFECTS OF
COMBINED ENVIRONMENTS
ON SYNCHROS TYPE 23TX6

BY

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COMPUTER ANALYSIS AND LABORATORY EVALUATION OF INTERACTION EFFECTS OF COMBINED ENVIRONMENTS ON SYNCHROS, TYPE 23TX6

DA Project 5B98-09-004

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February 1963

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ABSTRACT

This project investigates the adaptability of an analytical evaluation method developed by J. S. Arnold of Stanford Research Institute $1 \cdot , 2 \cdot$ to automatic data processing systems techniques for prediction of combined environments interaction effects.

Laboratory tests were performed on some typical environmental combinations and results were compared with the ADPS predictions for the same environmental combinations.

For the test items selected, the experimental results showed substantial agreement with the analysis and predictions from the computer.

^{1.} SYNERGISTIC EFFECTS IN COMBINED ENVIRONMENTS TESTING, by Mr. J. S. Arnold, Stamford Research Institute

^{2.} EFFECTS OF COMBINED ENVIRONMENTS, by Mr. J. S. Arnold, Stanford Research Institute

GLOSSARY OF TERMS AND DEFINITIONS

Test Unit (TU)

The smallest part of a complex mechanism upon which any of the environmental factors have a significant effect.

Simple Environmental Factors (SEF)

The physical attributes of the real environment that directly act upon the state of a test unit.

Simple Unit Parameters (SUP)

Those states of the test unit in which variations can be expected as the result of the forcing influences of the environment factor.

Electro-Magnetic State (EM)

The electric and magnetic conditions that exist in the TU, which may be either steady or fluctuating. Variables: voltage, current, magnetic flux, inductance, resistance, capacitance, field strength, hysteresis.

Strain State (STN)

The deformation produced by the stresses to which the TU is subjected, including the effects of internal stresses. Variables: deformation, shape, dimensions, compression, extension, distortion, expansion.

Elastic State (ELAS)

Includes the behavior properties of the TU with respect to deformation under steady or cyclic forces. Variables: Young's modulus, bulk modulus, loss, complex elastic modulus, spring constant, damping, shear modulus.

Chemical State (CHEM)

The reactions include the slow ones of mormal aging as well as the fast ones that describe the operation of chemically active devices. Variables: composition, reaction rate, contamination, ph, energy release (or absorption), reaction products.

High Temperature (Th)

Any environment condition that causes sensible heat input to the TU, so that its temperature approaches the design range maximum. Includes heat input by conduction, convection, radiation, condensation of hot vapor, etc.

Low Temperature (T1)

Any environment condition that causes sensible heat outflow from the TU, so that its temperature approaches the design range minimum. It includes heat outflows by conduction, convection, radiation, evaporation, etc.

Changing Temperature (Tc)

Any environment condition that causes sensible heat in- or outflow at a rate that approaches the design maximum. It includes much thermal situations as quenching, blast heat input, electrical discharge, violent chemical reaction, all forms of thermal shock.

High Pressure (Ph)

Any environment condition in which pressure that approaches the design range maximum is exerted on the TU. It includes air pressure, gas pressure, hydrostatic pressure, spring pressure.

Low Pressure (P1)

Any environment condition in which low pressure, approaching the design minimum, is exerted on the TU. It includes low atmospheric pressure, relief of normal pressurization, high altitude effects.

Changing Pressure (Pc)

Any environment condition that causes pressure change at a rate near the design maximum for the TU. Includes blast effects, shock phenomena, explosive decompression, cavitation.

Ionizing Radiation (Ri)

Any environment situation in which ionizing radiation is an input to the TU. Includes bombardment by X-rays, gamma rays, cosmic rays, ultra-violet-radiation and the various charged and uncharged particles that can produce ionization.

Mechanical Interference (Im)

Any environment situation in which components that are not properly a part of the TU can interfere mechanically with its operation. Includes dirt and dust accumulation, moisture condensation, biological material, mud, ice, snow, frost.

Relative Acceleration (Ar)

Any environment situation im which the TU is accelerated with respect to its surroundings, to produce forces that are near the design range maximum. Includes effects due to steady or varying acceleration, solid and airborne sound and vibration, wind and slipstream, propulsive thrust, drag, particle impingement.

Electric-Magnetic Fields (Fd)

Any environment situation in which the TU is subjected to steady or alternating electric or magnetic fields or electromagnetic radiation, the electric or magnetic effects of which approach the TU design range maximum. Includes fields from electric machines, electrostatic charge, magnets, coils, radiation from radar and communication apparatus.

Surrounding Chemical Composition (Cs)

Any environmental situation in which the chemical reaction potential of the surroundings (atmosphere, liquids and solids in contact with TU) approaches the TU design range maximum. Includes contaminated atmospheres, effects of chemical pollutants.

Time (2t)

An environmental situation in which there exists a time-dependent component in the definition of the design ranges of the parameters describing a test unit.

COMPUTER ANALYSIS AND LABORATORY EVALUATION OF INTERACTION EFFECTS OF COMBINED ENVIRONMENTS ON SYNCHROS, TYPE 23TX6

INTRODUCTION

This report covers work done at Frankford Arsenal in the continuation of research efforts previously performed by Stanford Research Institute under Contract DA-04-200-ORD-1032 and DA-04-200-ORD-1141, Department of Army Project No. 5B98-09-004, under the sponsorship of Mr. P. W. Espenschade, Chief, Environmental Research Office, Army Ordnance Corps (now Army Materiel Command).

Two previous reports have been published on this subject:
"SYNERGISTIC EFFECTS IN COMBINED ENVIRONMENTS TESTING" and "EFFECTS OF
COMBINED ENVIRONMENTS", both prepared by Mr. J. S. Arnold, Stanford
Research Institute, Menlo Park, California. The reports describe a
method of analysis utilizing automatic data processing machines to
permit better prediction of the effects of interaction of two or more
environmental factors on the functioning of Army material. The work was
analytical rather than experimental and had as its objective the treatment and analysis of the interactions of two or more environmental
factors and their effects.

The analysis involves the states that describe a test unit, the measurable physical parameters necessary to describe each of the states, the environmental factors that can be used to describe the environments, and the measurable physical parameters affected by each of the environmental factors. The proposed computer application of the analysis was developed in detail to a stage whereby a step-by-step procedure from input data (real environment and test unit descriptions) to output data (the environment action possibilities) can be traced.

The continuation of the research, herein reported, was performed jointly, by Mr. J. Arnold of Stanford Research Institute and Mr. M. H. Simpson of Frankford Arsenal under Department of Army Project No. 5B98-09-004. Machine analysis methods were set up for environmental interaction problems and solved with the use of a computer. Experimentation was performed to compare test results with the computer solutions.

OBJECT

To determine the interaction effects of vibration and low temperature, altitude and low temperature, and temperature and humidity on transmitter, forque, synchros type #23TX6 as a Test Unit (TU), and compare the test results obtained in the environmental laboratory with computer predictions programmed on a Remington Rand Solid State 90 Computer, in accordance with the analysis method developed by the Stanford Research Institute.

PROCEDURE

The selected test unit (TU) was a Transmitter, Torque, Synchro, Type #23TX6 shown in Figures 1 and 2. There were three phases of effort in the study. The first phase consisted of a Parts Analysis such as shown in Appendix 1, Sheets No. 1 thru 5. The second phase consisted of a computer program set up in accordance with the procedure outlined in Appendix 2, REQUIREMENTS FOR DATA ANALYSIS, SYNERGISTICS STUDY OF ENVIRONMENTAL INTERACTIONS, and Appendix 3, CATALOG A input and Appendix 4, CATALOG B input. The third phase was environmental laboratory testing for comparison of test results with qualitative computer solutions.

Phase 1. The parts analyses sheets were prepared as illustrated in the Appendix, to predict what Simple Unit Parameters (SUP's) might be affected by environmental action on that part.

Phase 2. For the computer phase, punched cards were used to set up the memory in a Remington Rand Solid State 90 Computer.

The following problems were given to the computer to predict:

- a. low temperature and altitude combined effects
- b. high temperature and high humidity combined effects
- c. vibration and low temperature combined effects

The data was submitted to the computer in accordance with the method developed by Stanford Research Institute; i.e.:

Given the TU (Test Unit - Synchro Type 23TX6).

and the following SUP's (Simple Unit Parameters) important to it in the environments concerned (See Glossary of Terms and Definitions):

EM - Electric-Magnetic State

STN - Strain State
ETAS - Elastic State
CHEM - Chemical State

and the effects:

- I Indirect effect of one environment.
- ID Indirect effect of one environment and direct effect of the second environment.
- D² Direct effect of two environments.
- I² Indirect effect of two environments.
- O No effect.

What effects can be expected from the combined SEF (Simple Environmental Factors) indicated below?

- a. Vibration and Low Temperature ArTl
- b. Altitude and Low Temperature PlT1
- c. Humidity and High Temperature CsTh

Phase 3 - The test phase consisted of subjecting the synchros to combined environments testing to the same combinations presented to the computer; i.e., Vibration and Low Temperature, Altitude and Low Temperature, and Humidity and High Temperature.

The environmental laboratory tests and the computer operations were performed at Frankford Arsenal,

DESCRIPTION OF COMBINED ENVIRONMENTS TESTING

Testing was performed during the period from August 1962 to October 1962. The Transmitter Torque Synchros, Type 23TX6, were electrically energized while being submitted to the following environmental conditions: Vibration and Low Temperature, Altitude and Low Temperature and High Temperature and Humidity. The test items were monitored for temperature changes, electrical continuity and for indications of arcing and/or short circuiting before, during, and after each test.

Vibration and Low Temperature Test #1 (Not Rotating)

The test set-up for the Vibration and Low Temperature Test (Figure 3) included the following pieces of equipment: LAB Type 24-200 Vibration Machine; Leeds & Northrup Speedomax multi-point temperature recorder, with copper-constantan thermocouples; Minneapolis-Honeywell Visicorder, Model 1108, Serial No. 11-164 an Endevco Model 2213 Accelerometer, 1½ Volt DC batteries, 45° synchro test fixture, and a liquid CO₂ portable cold chamber over the vibration machine. (See Figure 3).

Each of the three synchros was fastened to a 45° inclined fixture and the fixture was bolted to the vibration table. Thermocouples were placed on each synchro and in the air stream adjacent to the synchros. A continuous record of the temperatures was obtained by the Speedomax recorder. An accelerometer was fixed to the test fixture and the synchros rotors were energized with 1½ Volts D. C. without rotation. Records of acceleration and electrical continuity were obtained by the M-H Visicorder.

The liquid CO₂ refrigerated cold chamber was then placed over the set-up. The synchros were then subjected to -40°F and vibration characteristics of; (a) double amplitude - 0.141 inches vertical vibration, (b) variable frequency - 5 cps to 60 cps to 5 cps (c) a total scanning time of one minute for (d) a time duration of eight hours. The synchros were energized with 1½ Volts D. C. before, during, and after the -40°F test. (See Figures 5 and 6). The test items were monitored for temperature change, vibration and electrical continuity, continuously. Figure 4 shows the electrical schematic of the test set-up.

Vibration and Low Temperature Test #2 (Rotating)

The environmental test characteristics were the same as for Test #1; i.e. synchros were subjected to -40°F and vibration characteristics of 0.141 inches double amplitude vertically, with a sweep of frequency from 5 cps to 60 cps to 5 cps in a scanning time of one minute, for a total period of 6 hours.

The vibration machine and temperature test chamber were identical to those used for Vibration and Low Temperature Test \$1. In this test, however, the investigation of electrical characteristics was different. Four Synchros, Type 23TX6 were used for the test. Two synchros were used as driving units, mounted outside the cold box vibrator system and were electrically inter-connected with two additional Type 23TX6 Synchros mounted on the vibration machine and subjected to the vibration and low temperature environments. The driving synchros were, in turn, revolved by small motors thru flexible shaft combinations at 57 rpm and 60 rpm respectively. The follower, or driven synchros were positioned by the driving synchros. Electrical output of the driving synchros was 115 volts; resulting amperage was in accordance with data in Figure 8 and Appendix 7. Figure 7 shows the electric schematic of driver-driven synchrosystem.

Altitude and Low Temperature Test

The electrical measurements and test set-up for the Altitude - Low Temperature Test and the High Temperature - Humidity Test #1 were identical. (See Figures 4 and 9). Equipment used in these tests included: an altitude-temperature-humidity chamber, 45° synchro test fixture, copper constantan thermocouples, Esterline Angus Recording Ammeters, Model 4W, Serial Nos. 45846, 124180, 104091 (for electrical continuity), Foxboro Stabilog Pressure Temperature (altitude test only), L&N Speedomax Multipoint Temperature Recorder, Minneapolis-Honeywell Wet Bulb Temperature Recorder (humidity test only), and a 6 volt All-State 48 battery.

The synchros were mounted on the 45° test fixture and placed in the chamber. Thermocouples were placed on each synchro and in the air stream. Temperature records were obtained by the Speedomax Recorder. The items were energized by 6 volt D. C. and monitored by the Esterline Angus Recording Ammeters.

For the Altitude and Low Temperature Test, the altitude in the chamber was maintained at 10,000 feet (20.58 inches Hg absolute) by a pressure controller, while the temperature was held at -65°F. The synchros were energized with 6 volts D.C. before, during, and after the test. The test items were monitored continuously for both temperature and electrical continuity. This test had an 8 hour time duration.

Temperature and Humidity Test #1

The Temperature and Humidity Test #1 was performed with a temperature of 125°F and a relative humidity of 95% for a period of eleven days. During this time, records of temperature and humidity were taken continuously. The Synchros, Type #23T%6, were energized without rotation by 6 volts D. C. before, during and after the entire test and they were monitored for electrical continuity a minimum of one hour each morning and one hour each afternoon, taken at random times.

Temperature and Humidity Test #2

The Temperature and Humidity Test #2 differed from the Temperature and Humidity Test #1 by the method of electrical testing and length of test. The second test had the driver-driven combination of Type 23TX6 Synchros set up for Vibration and Low Temperature Test #2. All other requirements were the same as Temperature and Humidity Test #1; i.e., 125°F and 95% relative humidity, but for 5 days duration. Chamber temperature and humidity data were taken continuously during the test and the TU temperature and current drain were monitored for a period of 15 minutes each hour of the normal working day for the duration of the test.

RESULTS

Automatic Data Processing

The computer program was set up and the memory was stored in punched cards from Catalog A, Real Environmental Classifications, and Catalog B, Macro, Micro, Status Locations. (See Appendices 3 and 4). At no time did the operator time lapse amount to more than two minutes. Initial programming time amounted to four man days. (See Appendix 2 for programming requirements).

The computer solutions and predictions of combined effects on the Synchros, Type 23TX6 were as follows:

- 1. <u>Combined Effects of Vibration and Low Temperature</u>: that there would be an effect in strain and electrical properties of the test unit; i.e., ID effect.
- 2. Combined Effects of Low Temperature and Altitude: that there would be an effect in electrical and strain properties of the test unit, i.e., D² effect.
- 3. <u>Combined Effects of High Temperature and High Humidity</u>: that there would be an effect in chemical and electrical properties of the test unit; i.e., ID effect.

Environmental Tests

Vibration and Low Temperature Test #1

There was considerable arcing at normal room temperature with vibration in the frequency range of 35-60-35 cps, which was observed both visually and on the electrical monitoring Yecords. With the addition of low temperature $(-40^{\circ}F)$ a noticeable reduction in arcing occurs, as seen in Figure 6. The remaining arcing appears in the frequency range of 45-60-45 cps. Figures 5 and 6 show the results of vibration at room temperature and vibration with low temperature.

Vibration and Low Temperature Test #2

There was no change of amperage indicated in running current for both test units when exposed to -40° F air temperature as compared with operating amperage at normal ambient temperatures. Appendix 5 is the tabulated data and Figure 8 the plotted data of vibration at ambient and vibration at low temperature.

Altitude and Low Temperature

There is a definite increase in current drawn as the temperature decreases. It took the synchros 2 hours to stabilize at -65°F. During this time, the values of current drawn increased from 48 ms, 65 ms, and 63 ms (at ambient) to 87 ms, 106 ms, and 102 ms for synchros 1, 2, and 3 respectively. The changes in current drawn were 39, 41, and 39 ms. Since the voltage was held constant, an increase in current drawn indicates a decrease in electrical resistance. Figures 10 and 11 and Appendix 6 show the effects on electrical continuity of the synchros during the altitude - low temperature test.

High Temperature and High Humidity Test #1

With the test chamber temperature and humidity at 125°F and 95% relative humidity there was an immediate increase in current drawn by synchro #1 (from 50 to 58 ma) while synchros #2 and #3 decrease in current draw (from 65 to 59 mm for #2 and 63 to 57 for #3). After 12 days of the test the current draw of all three synchros stabilized and showed a definite increase in milliamperes. The final values of current were 62, 69, and 68 mm for synchros #1, #2 and #3. At one period during the test the chamber door was opened to see if any visual corrosion had taken place. While the door was open it was noticed that moisture had formed on the inside of the clear plastic top of synchros #1 and #3. When these test items were removed from the test fixture, it was noted that the rotors were locked tight. This was probably caused by corrosion due to humidity. This was later verified by disassembly of the synchros. There was corrosion of the ball bearings and raceway, and some corrosion on the brush contact points noted. Figure 12 and Appendix 7 exhibit the experimental data for this test.

High Temperature and Humidity Test #2

Results of this test show that running current increased by 2 amperes for 1 test unit, and 4 amperes for the second test unit, at 125°F and 95% relative humidity. There was some erratic functioning of one test unit (Synchro #4) noted at 4 different times. Corrosion was noted similar to High Temperature and Humidity Test #1, including locked rotors, corrosion of the ball bearings and raceway, and some corrosion of the brush contact points. Figure 13 and Appendix 8 exhibit the experimental data for this test.

ANALYSIS OF RESULTS

The following tabulated comparison of the results of the ADPS and experimental findings should be analyzed in terms of effects:

Table #1

Automatic Data Processing

	$\underline{\mathbf{p}^2}$	ID	<u>1</u> 2
Vibration and Low Temperature Low Temperature and Altitude	x	X	
High Temperature and Humidity	3.	X	

In order to check test results Table #2 is necessary:

Table #2

Experimental Effects

	Electrical Effect		Corrosion Effect
Vibration and Low Temperature	X	x	
Low Temperature and Altitude	X	X	
High Temperature and Humidity	X	X	x

In order to compare experimental results with ADP results, it is necessary to transpose Table #2 into ADP factors:

Table #3

Experimental in ADP Factors

	$\underline{n^2}$	ID
Vibration and Low Temperature	x	X
Low Temperature and Altitude	X	
High Temperature and Humidity	X	*

Note: X signifies occurrence.

From the foregoing data there is apparently some lack of agreement in the results of the automatic data processing prediction and experimental results. Comparing results in Table 3 (Experimental in ADP Factors) with results in Table 1 (Automatic Data Processing) D^2 effects were not predicted by the computer for two of the three test conditions but did occur for all three during the experiment. These D^2 effects occurred in the Vibration and Low Temperature Tests and the High Temperature and Humidity Tests. There was agreement in all other occurrences.

It should also be noted that the experimental results indicated a direct effect of temperature on current flow (due to resistance changes in the windings) as well as an indirect effect of temperature causing current changes (due to mechanical strain producing a relative change in spring contact resistance).

Comparison of experimental results with computer predictions revealed that:

- 1. Most of the effects observed after the combined environments tests were predicted by the computer analysis.
- 2. No combined environmental effects were found which the analysis indicated to be impossible.
- 3. The computer did not distinguish between the direct effect (D) and the indirect effect (ID) of a single environment on different parameters.
- 4. The computer did not evolve a double effect (D^2 and ID) as being inherent in the Vibration and Low Temperature, and High Temperature and Humidity Tests, but predicted only that there would be an indirect effect.

Note: The inconsistencies of paragraph 3 and 4 are probably due to incomplete parts analyses made by the analyses in preparation of Catalogs A and B, and not necessarily a fault of the method.

CONCLUSIONS

The general conclusion of the investigation, based on the experimental findings, is that the proposed method of analysis and use of computers has merit for environmental evaluation of military material. The objective was to test the method. The effects observed could be beneficial or deleterious. The purpose was not to evaluate "good-or-bad", but to predict an effect; and this was demonstrated.

It may be possible that quantifying values could be applied to measure effects on parameters. However, further refinements on the qualified effects, especially relative to the prediction of direct and indirect effects of single and combined environments, should be made first before quantifying effects should be attempted. It is further concluded that additional investigation is warranted in pursuing this environmental evaluation and analysis method in order to determine whether a quantifying system could be attainable.

RECOMMENDATIONS

Since there is indication that benefits can be attained in the form of increased material reliability and reduced material cost by supplementing and/or replacing portions of environmental testing by analytical procedures, the use of analytical techniques with computer storage and manipulation of data will have great utility, especially in the prediction of combined environments effects. Analysis of data relating environments to test unit effects would be of considerable value in the determination of which environmental factors are important for the evaluation of a test unit and the reduction of requirements for testing.

The information required in environmental effects analysis is generally available, at present, in the form of texts, tables, books, reports, the experience of individuals, etc., but it is so scattered that all pertinent data are not usually brought to bear on a specific problem because of the magnitude of the task of assembling and using it. The machine analysis approach to the environmental problem is that of acquiring all the data in general form and storing it in the machine memory. An incoming problem can then be placed in such a format that all pertinent data in the machine's memory will be searched out and qualitative and quantitative aspects of the actions of environmental forces upon the materials and mechanisms will be determined more rapidly.

It is recommended that consideration be given to amplifying the investigation into a wider scope of effort. The suggested effort would include the following activities:

- 1. Automatic Data Processing Systems should be further studied for application to the environment-material interaction problem primarily to determine their capability for manipulating the data.
- 2. The present descriptions of climatic, geographic, and induced environments should be studied and methods for transforming these descriptions into the terms necessary for application to Automatic Data Processing should be developed.
- 3. The physical characteristics of material that are affected by environmental phenomena should be studied in order to define success and failure criteria for military operations.

- 4. Methods for the acquisition of data describing field materiel failures, and the cataloging and storage of these data for application to future problems, should be studied and evaluated for application for environmental factors.
- 5. The development of the analytical format in which the information is to be used should be continued as the information fund increases in size and scope.

APPENDIX 1

Part Analysis Sheet

Sheet No	1			
P. No.	7645534	TU No	11	SUP
P. Name	Front End Bell			
P. Function	Support Bear	ing, Close	Synchro	

Induce	d Environment Factors Caused by P None	No	Yes
CHEM	PO require chemical reaction?	x	
	External surface reactions (corrosion, rust) affect PO?	x	
	Volume reaction (displacement, solution) affect PO?	X	
	Slow (aging) reaction affect PO?	X	
CLN	Contaminants affect cooperation with other P?	x	
	Necessary thermal behavior impaired by contaminants?	X	
	Necessary surface characteristics (optical, electrical) impaired?	x	
ELAS	P has vibration isolation function?	X	
	P has strain relief function?	X	
	P has function of protecting other P?	X	
	PO require specific spring constant?	X	
EM	PO require EMF or MMF from P?	x	
	Can external E or M fields affect PO?	X	
	PO require specific electrical properties?	X	
	PO require specific magnetic properties?	X	
RHEO	PO require specific viscosity of P?	x	
	PO depend on circulation of P?	X	
	Cold or slow flow of P affect PO?	X	
	Viscous damping by P affect PO?	X	
STN	Steady or cyclic external strain on P affect PO?	x	
	Body force (steady or cyclic) on P affect PO? .	X	
	Direction of gravity affect PO?	X	
	Strain-sensitive alignment of P affect PO?	X	
STR	Can state change occur in P to affect PO?	X	
	PO dependent on microstructure of P?	X	
	Allotropic changes in P affect PO?	X	
	Polymerization changes in P affect PO? Surface structure changes in P affect PO?	X	
THER	Temperature of P affect PO?	x	
	Heat generation in P affect PO?	X	
	Heat conversion in P affect PO?	X	
	Heat transfer in P affect PO?	X	

Note: P = Part, PO = Part Operation #.

Sheet	No. 2	4,
P. No	583474 TU No. SUP	
P. Nan	Retaining Ring	ELAS
P. Fur	action Hold Closure in Place STN	
Induce	ed Environment Factors Caused by P None	No Yes
CHEM	PO require chemical reaction? External surface reactions (corrosion, rust) affect PO? Volume reaction (displacement, solution) affect PO? Slow (aging) reaction affect PO?	x x x x
CLN	Contaminants affect cooperation with other P? Necessary thermal behavior impaired by contaminants? Necessary surface characteristics (optical, electrical) impaired?	X X
ELAS	P has vibration isolation function? P has strain relief function? P has function of protecting other P? PO require specific spring constant?	x x x
EM	PO require EMF or MMF from P? Can external E or M fields affect PO? PO require specific electrical properties? PO require specific magnetic properites?	x x x
RHEO	PO require specific viscosity of P? PO depend on circulation of P? Cold or slow flow of P affect PO? Viscous damping by P affect PO?	x x x
STN	Steady or cyclic external strain on P affect PO? Body force (steady or cyclic) on P affect PO? Direction of gravity affect PO? Strain-sensitive alignment of P affect PO?	x x x
STR	Can state change occur in P to affect PO? (Can state change occur in P to affect PO? (Can state changes in P affect PO? (Can state change occur in P to affect PO? (Can state change occur in P	x x x x
THER	Temperature of P affect PO? Heat generation in P affect PO? Heat conversion in P affect PO? Heat transfer by P affect PO?	X X X

Sheet	No							
P. No.	8570216	TU No	11	SUP				
P. Nam	e Ball Bearing	_		CHEM.	CLN			
P. Fun	ction Support Rotor	_			STN			
Induce	d Environment Factors C	aused by P _	None		 	No	Yes	
CHEM	PO require chemical re	action?				x		
	External surface react		ion, rust)	affect PC	?		X	
	Volume reaction (displ		ution) af:	fect PO?		X		
	Slow (aging) reaction	affect PO?				X		
CLN	Contaminants affect co	operation wi	th other I	P?			x	
	Necessary thermal beha	-				X		
	Necessary surface char impaired?	acteristics	(optical,	electrical	.)	x		
ELAS	P has vibration isolat	ion function	?			x		
	P has strain relief fu	nction?				X		
	P has function of prot	-				X		
	PO require specific sp	ring constan	t?			X		
EM	PO require EMF or MMF	from P?				X		
	Can external E or M fi	elds affect	PO?			X		
	PO require specific el	-	•			X		
	PO require specific ma	gnetic prope	rties? .			X		
RHEO	PO require specific vi	scosity of P	?			X		
	PO depend on circulati	-	•			X		
	Cold or slow flow of H	affect PO?				X		

X

X

X

X

Viscous damping by P affect PO? .

Heat conversion in P affect PO? Heat transfer by P affect PO?

STN

Steady or cyclic external atrain on P affect PO?

Sheet	No.	4	-				
P. No	•	8570257	_ TU No	1	SUP		
P. Nan	ne	Rotor Assy	_		CHEM	CLN	EM
P. Fur	action	Rotate in Field	-			STR	THER
Induce	ed Envi	ironment Factors Cau	used by P HF	ield in S	Stator	No	Yes
CHEM	Exter	equire chemical read rnal surface reaction me reaction (displace	ons (corrosion,	•		x x	x
		(aging) reaction as	=	, -22500		x	
CLN	Conte	minants affect coop	eration with ot	her P?			x
	Neces	ssary thermal behavi ssary surface charac ired?				X.	x
ELAS	P has	s vibration isolation strain relief fund function of protection of protection specific spring	ction? cting other P?			X X X	
EM	Can e	equire EMF or MMF fr external E or M fiel equire specific elec equire specific magn	lds affect PO? strical properti				X X X X
RHEO	PO de Cold	equire specific visc epend on circulation or slow flow of P a ous damping by P afi	n of P? Affact .PO?	•		X X X	
STN	Body Direc	ly or cyclic externs force (steady or cyction of gravity aff in-sensitive alignment	clic) on P affe fect PO?	ct PO?	? ,	X X X	
STR	PO de Allot Polyn	state change occur is pendent on microstructions in Perization changes in the structure changes	ructure of P? affect PO? . in P affect PO?	•		x x x	x
THER	Heat Heat	erature of P affect generation in P aff conversion in P affect	fect PO? fect PO?	•		x	X X

Sheet 1	No.	د5	•	S. A. Links			
	,	7595533					
P. No.		7595541	TU No	1	SUP		
P. Name	e	Brush Assy	·			CLN I	elas em
P. Fun	ction	Contact Slip R	ings			STN	
Induce	d Envi	ronment Factors	Caused by P	None		No	Yes
CHEM	PO re	quire chemical r	eaction?		•	X	
		nal surface reac		n, rust) affe	ct PO?	X	
	Velum	e reaction (disp	lacement, solut:	ion) affect P	20? .	X	
	Slow	(aging) reaction	affect PO?	•	,	X	
OT W	0			-4b 72			-
CLN		minants affect co sary thermal beh			***		x
		sary surface char				X	
	impai	•	TWC PATTECTOR (A)	percer, erest		. ~	
			-		•		
ELAS	P has	vibration isola	tion function?			X	
	P has	strain relief f	unction?			X	
	P has	function of pro	tecting other P	?		X	
	PO re	quire specific s	pring constant?	•			X
EM	PO TO	quire EMF or MMF	from P?			x	
		xternal E or M f		?		^	x
		quire specific e					x
		quire specific m				x	
				,			
RHEO		quire specific v	*			X	
		pend on circulat				X	
		or slow flow of i				X	
	ATRCO	us damping by P	RILECT PUI ,			•	
STN	Stead	y or cyclic exter	rnal strain on i	P affect PO?			X
	Body	force (steady or	cyclic) on P a	ffect PO? .		X	
	Direc	tion of gravity	affect PO?			X	
	Strai	n-sensitive alig	nment of P affe	et PO?			X
STR	Can s	tate change occur	r in P to Affect	t P07		x	
DIK		pendent on micro				Ŷ	
		ropic changes in		•		x	
		erization change		0?		X	
	•	ce structure cha		_		X	
	_		. 500	•			
THER	-	rature of P affe				X	
		generation in Paconversion in Pa				X	
		transfer by P af				X	

APPENDIX 2

REQUIREMENTS FOR DATA ANALYSIS

SYNERGISTICS STUDY OF ENVIRONMENTAL INTERACTIONS

The numerical entries of Catalog A and Catalog B are to be stored in the computer memory as tables, subject to withdrawal and readout when requested in accordance with certain conditions. The Catalog A entries consist of a variable number of digits, up to a maximum of 16, which refer to simple environmental factor (SEF), and the real environments in which they are found. The real environment code is on the first page of Catalog A, and the SEF code on the first page of Catalog B. (See Appendices 3 and 4).

A typical Catalog A entry might be as follows:

1.2	22	11	01	02	11	12
Macro	Micro	Status	SEF1	SEF ₂	SEF ₁₁	SEF ₁₂
Location	Location		(Ar)	$(C_{\mathbf{s}})$	(T_)	(z_t)

The first 3 pairs denote the rest environment (Arctic, in a surface vehicle, under cover) and the last four pairs denote the simple environment factors that are operating (acceleration, non-standard chemical surroundings, low temperature, and aging).

Catalog B entries consist of four two-digit pairs. The first two of these indicate the two SEF that are considered. The third pair denotes the state (SUP) of the test unit upon which the SEF acts, and the fourth pair indicates the type of effect. As an example, such an entry might be:

02	09	07	02
SEF	SEF2	SUP	Effect
(Ca)	(Ta)	(STR)	<u> 7</u> 2

The first 2 pairs indicates the two SEF (chemical surroundings and changing temperature). The third pair indicates the strain state of the lest unit, and the fourth pair indicates an $I_{\rm g}^2$ (or least probable) effect.

Simplest Operation (1)

The simplest operation will be the readout of entries in the above catalogs. For example, the operator may wish to know the SEF corresponding to a given real environment. He therefore asks for a readout of the entry corresponding to a real environment. He thus puts in an instruction to readout the Catalog A entry beginning with the six digits that correspond to the real environment. Similarly with Catalog B, in which case his instructions might be to print out an B digit entry, of which 6 digits are known. In some cases only four or perhaps two of the digits will be known, and the resulting readout must include all the entries that contain these digits in the specified positions.

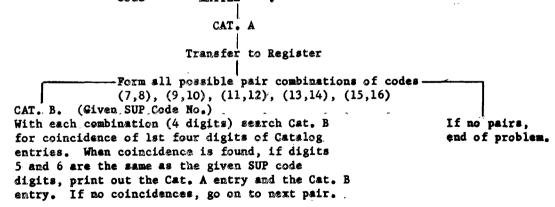


2nd Operation (Problem)

This operation is one in which a real environment (RE) is given, and the important state of a test unit (SUP) is given, and it is desired to find how the RE affects the SUP. The following steps are indicated:

- (1) Find the SEF that describes the real environment by supplying the real environment code number (6 digits) and instructing the machine to find the SEF code numbers from Catalog A.
- (2) Form all possible pairs of these code numbers (4 digit groups). It is hoped that this operation can be done in the machine, but it can be done by the operator after a readout if there is no better way.
- (3) Take each 2 SEF pair, search Catalog B, find the pair or the first four digits of an entry, apply the condition that the given SUP code number be the 3rd pair of the entry. When this condition is satisfied, print out the complete Catalog A and Catalog B entries.

Instructions: Find the Cat. A entry corresponding to the given R. E. code XXYYZZ----.



In the step that leads to the above readout, it would be desirable to include still another condition - the coincidence of the last two columns of the Catalog B entry with a given value. This would emable operator to get only a print out of the environmental effects of a prescribed kind (01, 02, 03, or 04).

3rd Operation

Given a TU and the SUP important to it. What real environments will affect it?

Instructions:

CAT. B.

With the given SUP code search and print out all Cat. B. entries that have this code number in columns (5,6) and 02, 03, or 04 in columns (7,8).

CAT. A.

Using the resulting SEF pair columns (1,2), (3,4), search Cat. A columns (7,8), (9,10), (11,12), (13,14), (15,16). When coincidences are found, print out the entire Cat. A entry.

APPENDIX 3

Catalog A

Real Environment Classification

	Macro-location		Micro-location		Status
10 11 12	Arctic Ice Cap Inland	11 12	Stationary In Open Overhead Shelter	11 12	Z of I Storage-Boxed Storage-Exposed
13	Maritime	13 14	Enclosed Space Temp. Controlled Space	13 14	Standby Operation
20 21	Temperate Continental	21	Surface Vehicle In Open	21	T of 0 Storage - Boxed
22	Desert	22	Overhead Shelter	22	Storage - Exposed
23	Highland	23	Enclosed Space	23	Standby
24	Maritime	24	Temp. Controlled Space	24	Operation
30	Tropical		Sea Vehicle		
31	Desert	31	In Open		
32	Highland	32	Overhead Shelter		
33	Jungle	33	4		
34	Maritime	34	Temp. Controlled Space		
			Flight Vehicle	•	
		41	No Press. or Temp. Cont	LOT	
		42	Pressurised, Unheated		
		43	Unpressurized, Heated		
		44	Pressurized, Heated		

Using above classification, with following order.

Macre-location	Micro-location	Status
lst 2 digits	2nd 2 digits	3rd 2 digits

get a digit group prepresenting real climatic and geographical environment.

Example: Environment of a spare tire on a jeep in Vietnam would probably be coded.

33 21 23

33 - Tropical Jungle

21 - In Open on Land Surface Vehicle

23 - T. of O. Standby

Next step - Assign SEF to environment descriptions. These will be assigned on basis of most obvious ones first, keeping the number of SEF assigned to a minimum for this go-round. SEF will be assigned to represent deviations from the standard temperate (Ac) environment of construction of most devices. In the context of the report, they are to represent the differences between the ambient environments Ac and Ad or Ax.

2000

Tof 0 - Table not prepared.

Zof I - Will illustrate in following tables.

LANGUAGE Real Environment				CODE										
				SEF	Real Environment					SEF				
of I	Ice	Cap,	In Op	en, Bo	oxed		Tl,Zt	11	11	11	11	12		,
	16	11	11. 11	E	xpos	ed	T1, Im, Zt, Pn	"	**	12	04	06	11	12
	11	84	11 11	S	tandi	by	T1,Im	"	11	13	04	11		
	11	"	11 11	O	pera	tion	Tl,Im	11.	71	14	04	11		
	**	**	Roof,	Boxe	d.		T1,Zt	11	12	11	11	12		
	11	**	11	Expo			Tl,Im,Zt	#1	11	12	04	11	12	
	**	**	11	Stan			Tl,Im	"	н	13	04	11		
	1,5	**	11	Opera		n	Tl,Im	"	**	14	04	11		
	**	11	Encl.	Space	e R	oxed	T1,Zt	11	13	11	11	12		
	**	iı	11	11		xposed	Tl,Zt	11	11	12	11	12		
•	**	**	11	11		tandby	TI	11	11	13	11			
	**	**	11	11:		peration	Tl	ij	H	14	11			
	11	11	Temp.	Cont	Bo.	rad	Zt	11	14	11	11			
	**	**	Temb.	H			Zt	11	11	12	11			
	**	11	11	11		posed		**	11	13	-			
		"	11	"		andby	-	11	11	14				
	••	••	••	••	U p e	eration	-		••	14	-			
	17	11	Surf.	Veh.	Ope	n Boxed	Tl,Ar,Zt	11	21	11	01	11	12	
	11	**	11	11	11	Exp.	T1, Ar, Im, Zt	11	**	12	01	04	11	12
	11	11	11	11	**	Stdby	Tl,Ar,Im	11	11	13	01	04	11	
	**	**	11	11	**	Oper.	Tl,Ar,Im	**	11	14	01	04	1,1	
	*1	11	**		о.н в	. Shelt	Tl,Ar,Zt	11	22	11	01	11	12	
	11	11	"	"		. Shelt	T1,Ar,Im,Zt		11	12	01	04	11	12
	11	11	**	11	O.H	. Shelt	Tl,Ar,Im	. 11	**	13	01	04	11	
	**	11	**	11		. Shelt	Tl,Ar,Im	11	#1	14	01	04	11	
						ration	Trourer				01	V	••	
	**	#1	**	n	Enc	1 Bx	Tl,Ar,Zt	11	23	11	01	11	12	
	11	**	11	11	11	Exp.	T1,Ar,Zt	ų, ų,	-	12	01	11	12	
	ú	**	ú	11	11	Stdby	Tl,Ar	11	H.	13	01	11	*-	
	11	11	"	ņ	11	Oper.	Tl,Ar	11	ń	14	01	11		
	**	**	11	11	HTD	Rw	Ar,Zt,Tc	11	24	11	01	09	12	
	FI	11	II .	11	11	Exp.	Ar,Zt,Tc	11	11	12	01	09	12	
	11	**	11	11	11	Stdby		11	**	13	01	09	12	
	11	**	"	11		•	Ar,Tc		11	14	01	09		
	••	• •	-;		••	Oper	Az			14	υŢ	C)		

CODE REAL ENVIRONMENT

CODE SEF

REAL ENVIRONMENT					SEL			
Macro	Micro	Status						
11	31	•	Not	App:	licabi	le		
10	41	11	01	05	11	12		Tl,Ar,Pc,Zt
11	"	12	01	05	11	12		Tl,Ar,Pc,Zt
11	#1	13	01	05	11	alle der		Tl,Ar,Pc
11	11	14	01	05	11			Tl,Ar,Pc
		A*	OI.	UJ	A.L			Lagna,56
10	42	11	01	11	12			Tl,Ar,Zt
11	6.0	12	01	12	12			Tl,Ar,Zt
tī	11	13	01	11				Tl,Zr
11	11	14	01	11				Tl, Ar
10	43	11	01	05	09	12		Tc,Ar,Pe,Zt
11	11	12	01	05	09	12		Tc, Ar, Pc, Zt
11	**	13	01	05	09	-41		Tc,Ar,Pc
**	**	14	01	05	09			Tc,Ar,Pc
		14	01	05	09			IC, AE, FC
10	44	11	01	09	12			Tc,Ar
11	11	12	01	09	12			Tc,Ar
11	ti	13	01	09				Tc,Ar
**	11	14	01	09				Tc,Ar
12	11	11	02	11	12			Tl,Cs,Zt
11	ii -	12	02	04	06	11	12	Tl,Cs,Ph,Zt,Im
98	11	14	02	04	11		-4.	Tl,Cs,Im
		**	02	Ο Ψ				r w 3 to 3 tm
12	12	11	02	11	12			Tl,Cs,Zt
11	**	12	02	04	11	12		Tl,Cs,2t,Im
11	11	13	02	04	11			Cs, Im, Tl
**	11	14	02	04	11			Cs, Im, Tl
12	13	11	11	12				T1,Zt
#. &. 11	11	12	11	12				
11	11	13	11	4.4				T1,Zt T1
11	11							
	,,	14	11					T1
12	14	11	12					Zt
11	11	12	12					Zt
11	11	13	-					
It	11	14	•					
12	21	11	01	02	11	12		T1,A1,Zt,Cs
A.G. 11	11	12	01	02	04	11	12	Tl.Ar.Zt.Cs.Im
 (1	11	13	01	02	04	11	44	
15	" "							Tl, Ar, Im, Gs
••	••	14	01	02	04	11		Tl,Ar,Im,Cs

	R. E.			······································	SE	<u> </u>		
Macro	Micro	Status			С	ODE		
12	22	11	01	02	11	12		Tl,Ar,Zt,Cs
II	11	12	01	02	04	11	12	T1,Ar,Zt,Cs,Im
11	11	13	01	02	04	11		Tl,Ar,Cs,Im
11	11	14	01	02	04	11		Tl,Ar,Cs,Im
12	23	11	01	02	1.1 -1:	12		Tl,Ar,Zt,Cs
19	11	12	01	02	11	12		Tl,Ar,Zt,Cs
11	11	13	01	02	11			Tl,Ar,Cs
11	11	14	01	02	11			Tl,Ar,Cs
12	24	11	01	02	09	12		Ar,Zt,Cs,Tc
11	11	12	01	02	09	12		Ar,Zt,Cs,Tc
**	"	13	01	02	09			Ar,Cs,Tc
**	ņ	14	01	02	09			Ar,Cs,Tc
12	31	11	Not	Applic	able			
13	11	11	02	11	12			Tl,Zt,Cs
11	11	12	02	04	06	11	12	T1,Zt,Cs,Im,Ph
11	**	13	02	04	11			T1,Cs,Im
11	*1	14	002	04	11			Tl,Cs,Im
13	12	11	02	11	12			Tl,Zt,Cs
11	**	12	02	04	11	12		T1,Zt,Cs,Im
11	11	13	02	04	11			T1,Cs,Im
Pf	**	14	02	04	11			Tl,Cs,Im
13	13	11	02	11				Tl,Zt,Cs
11	**	12	02	11	12			Tl,Zt,Cs
11	**	13	02	11				T1,Cs
11	**	14	02	11				Ti,Cs
13	14	11	02	12				Ca,Zt
17	11	12	02	12				Ca,Zt
68	11	13	02					Cs .
11	11	14	02					C.
13	21	11	01	02	11	12		Tl,Zt,Ar,Cs
ti	11	12	01	02	04	11	12	Tl,Zt,Ar,Cs,Im
11	**	13	01	02	04	11		Tl,Ar,Cs,Im
11	11	14	01	02	04	11		Tl,Ar,Cs,Im
13	22	11	01	02	11	12		Tl,Zt,Ar,Cs
11	11	12	01	02	04	11	12	Tl,Zt,Ar,Cs,Im
11	11	13	01	02	04	11		Tl,Ar,Cs,Im
"	11	14	01	02	04	11		Tl,Ar,Cs,Im

	R. E.				SE	<u> </u>	······································	
Macro	Micro	Status			С.	ODE		
12	22	11	01	02	11	12		Tl,Ar,Zt,Cs
H	11	12	01	02	04	11	12	T1,Ar,Zt,Cs,Im
11	11	13	01	02	04	11		Tl,Ar,Cs,Im
11	*1	14	01	02	04	11		Tl,Ar,Cs,Im
12	23	11	01	02	14 4	12		Tl,Ar,Zt,Cs
19	17	12	01	02	11	12		Tl,Ar,Zt,Cs
16	11	13	01	02	11			Tl,Ar,Cs
11	11	14	01	02	11			Tl,Ar,Cs
12	24	11	01	02	09	12		Ar,Zt,Cs,Tc
11	11	12	01	02	Ó9	12		Ar,Zt,Cs,Tc
*1	**	13	01	02	09			Ar,Cs,Tc
	ii	14	01	02	09			Ar,Cs,Tc
12	31	11	Not	Applic	cable			
13	11	11	02	11	12		•	Tl,Zt,Cs
11	**	12	02	04	06	11	12	T1,Zt,Cs,Im,Ph
11	**	13	02	04	11			T1,Cs,Im
11	11	14	⊕02	04	11			Tl,Cs,Im
13	12	11	02	11	12			Tl,Zt,Cs
11	**	12	02	04	11	12		T1,Zt,Cs,Im
11	11	13	02	04	11			Tl,Cs,Im
11	11	14	02	04	11			Tl,Cs,Im
13	13	11	02	11				Tl,Zt,Cs
!!	**	12	02	11	12			T1,Zt,Cs
**	*1	13	02	11				T1,Cs
11	**	14	02	11				T1,Cs
13	14	11	02	12				Ca,Zt
**	"	12	02	12				C s ,Zt
**	**	13	02					Cs
**	**	14	02					C8
13	21	11	01	02	11	12		Tl,Zt,Ar,Cs
11	11	12	01	02	04	11	12	T1,Zt,Ar,Cs,Im
11	**	13	01	02	04	11		Tl,Ar,Cs,Im
**	**	14	01	02	04	11		Tl,Ar,Cs,Im
13	22	11	01	02	11	12		Tl,Zt,Ar,Cs
**	11	12	01	02	04	11	12	Tl,Zt,Ar,Cs,Im
11	**	13	01	02	04	11		Tl,Ar,Cs,Im
11	11	14	01	02	04	11		Tl,Ar,Cs,Im

R. E.

SEF

Macro	Micro	Status				cc	DE	
13	23	11	01	02	11	12		Tl,Cs,Zt,Ar
11	11	12	01	02	11	12		Tl,Cs,Zt,Ar
• 0	11	13	01	02	11	da da		Tl,Cs,Ar
н	. ••	14	01	02	11			Tl,Cs,Ar
13	24	11	01	02	09	12		Cs,Ar,Zt,Tc
19	<u> </u>	12	01	02	09	12		Cs, Ar, Zt, Tc
18	11	13	01	02	09			Ar,Cs,Tc
**	17	14	01	02	09			Ar,Cs,Tc
13	31	11	01	02	11	12		Same as
9 0	**	12	01	02	04	11	12	13211X
10	11	13	01	02	04	11		
**	11	14	01	02	04	11		
13	32	11	01	02	11	12		Same as
**	t1	12	01	02	04	11	12	13221X
11	11	13	01	02	04	11		
**	11	14	01	02	04	11		
13	33	11	oì	02	11	12		Same as
11	11	12	01	02	11	12		13231X
11	11	13	01	02	11			
11	11	14	01	02	11			
13	34	11	01	02	09	12		Same as
31	01	12	01	02	09	12		13241X
**	*1	1.3	01	02	09			
10	18	14	01	Q2	09			
13	4 X	1.%	Not	Applic	able			
20	41	11	oı	05	07	09	11	T1,Tc,Ar,Pc,P1
89	11	12	01	O 5	07	09	11	Tl,Tc,Ar,Pc,Pl
9.0	11	13	01	05	07	09	11	Tl,Tc,Ar,Pc,Pl
0.0	11	14	01	0 5	07	09	11	Tl,Tc,Ar,Pc,Pl
20	42	11	01	09	11			Ar,Tl,Tc
00	51	12	01	09	11			Ar, Tl, Tc
11	#1	13	01	09	11			Ar,T1,Tc
11	11	14	01	09	11			Ar,T1,Tc
20	43	11	01	05	07			Ar,Pl,Pc
11	11	12	01	05	07			Ar,Pl,Pc
11		13	01	05	07			Ar,P1,Pc
.0	11	14	01	05	07			Ar,Pl,Pc

	R. E.		V+		SEF		
Macro	Micro	Status			CODE	<u>-</u>	
20	44	11	01				Ar
11	11	12	01	·· 6·			Ār
11	**	13	01				Ar
**	**	14	01				Ar
21	1X	1 X	•				None (Def)
21	21	11	01	03			Ar,Fd
11	11	12	01	03			Ar , Fd
**	11	13	01				Ar
**	**	14	01				Ar
21	22	11	01	03	12		Ar, Fd, Zt
11	<u> </u>	12	01	04	12		Ar,Im,Zt
11	11	13	01	04			Ar , Im
11	11	14	01	04			Ar,Im
21	23	11.	01	12			Ar ,Zt
11	11	12	01	12			Ar ,Zt
11	н	13	01				Ar
10	**	14	01				Ar
		14	01				AL.
21	24	11	01				Ar
10	**	12	01				Ar
11	**	13	01				Ar
"	11	14	601				Ar
21	3 x	ix	Not	Applic	able		
21	4 X	1%	Not	Applic	cable		
22	11	11	£ 03 -	09	10		Th,Tc,Fd
11	н	12	03	04	08	10	Th,Ri,Im,Fd
11	11	13	03	04	08	10	Th,Ri,Im,Fd
**	11	14	03	04	08	10	Th,Ri,Im,Fd
22	12	11	10				Th
11	11	12	04	10	r.		Th, Im
11	11	13	04	10	,		Th,Im
11	11	14	04	10	,		Th,Im
22	13	11	10				Th ·
11	11	12	10				Th
11	11	13	10				Th
11	Ħ	14	10				Th
22	14	11	-				•
11	11	12	-				-
"	It	13	-				
"	11	14	_				<u>.</u>
••		1,4	-				~

SEF

								
Macro	Micro	Status		COD	E			
22	21	11	01	09	10			Th,Tc,Ar
**	**	12	01	04	08	10		Ar, Im, Ri, Th
H	**	13	01	04	08	10		Ar, Im, Ri, Th
11	11	14	01	04	08	10		Ar, Im, Ri, Th
22	22	11	01	09	10			Th,Tc,Ar
11	11	12	01	04	10			Th, Im, Ar
11	11	13	01	04	10			Th, Im, Ar
11.	11	14	01	04	10			Th, Im, Ar
22	23	11	01	10				Th , Ar
F1	11	12	01	10				Th , Ar
**	11	13	01	10				Th, Ar
11	11	14	01	10				Th,Ar
22	24	11	01					Ar
**	**	12	01					***
**	11	13	01					11
11	11	14	01					11
22	3 X	1X	Not	Applic	able			
22	4 x	1X	Not	Applic	able			
23	11	11	03	10	11			Th,Tl,Fd
11	11	12	03	04	08	10	11	Th, Tl, Im, Ri, Fd
11	11	13	03	04	08	10	11	Th,Tl,Im,Ri,Fd
11	11	14	03	Q4	08	10	11	Th, Tl, Im, Ri, Fo
23	12	11	10	11.				Th,Tl
11	11	12	04	11				Tl, Im
11	ij	13	04	11				Tl,Im
**	n	14	04	11				Tl,Im
23	13	11	11					Tl
II 	11	12	11					Tl
11	**	13	11					Tl
11	11	14	11					Tl
23	14	11						•
**	11	12	•					•
11)1 	13	•					₽
11	11	14	•					-
23	21	11	01	10	11			Th, Tl, Ar
		12	01	04	08	11		Tl,Ar,Ri,Im
!! 	11	13	01	04	08	11		Tl, Ar, Ri, Im
ii.	**	14	01	04	08	11		Tl,Ar,Ri,Im

	R. E.				SEF	
Macro	Micro	Status			CODE	•
23	22	11	01	11		Te,Ar
n,	11	12	01	04	11	",Im
11 .	. 19	13	01	04	11	M H
10	ú	14	01	04	11	n i
23	23	11	01	11		Te,Ar -
11	11	12	01	11		и
11	**	13	01	11		18
3.8	11 11	14	01	11		11
23	24	11	01			Ar
11	11	12	01			Ar "
**	# #	13	01			!! !t
i.	i	14	01			tt
24	11	11	02			Cs
11	**	12	02	08		Cs,Ri
ij	**	13	02	08		Cs,Ri
49 18	ij	14	02	08		Cs,Ri
24	12	11	02			Ćs
19	**	12	02			"
11	#1 !	13	02			**
11 11	**	14	02			re tt
24	13	11	02			Cs
ii .	H	12	02			"
ii.	ij	13	02			1
ij	**	14	02			1† • •
24	14	11	02			Cs
11	11	12	02			n
ij	ij	13	02			ij
û	ii.	14	02			!! !!
24	21	11	01	02		Ar,Cs
11	11	12	01	02	08	" " Ri
97	ii ii	13	01	02	08	n ii n
ii		14	01	02	08	tt 10
24	22	11	01	02		Ar,Cs
19	11	12	01	02		12
11	11 11	13	01	02		!!
*9	ij	14	01	02		₩ •
24	23	11	01	02		Ar,Cs
Ħ	••	12	01	02		,
18	n n	13	01	02		
11	ù	14	01	02		

	R. E.	· · · · · · · · · · · · · · · · · · ·		SE	<u> </u>			
Macro	Micro	Status	 	CO	DE			
24	24	11	01	02				Cs,Ar
91	11	12	01	02				11
10	11	13	01	02				17
ij	ii.	14	01	02				ij
24	31	11	01	0.2				Cs ,Ar
10	"	12	01	02	08			" & Ri
19	ņ	13	01	02	08			££ 19
88	ú	14	01	02	08			ų s
24	32	11	01	02				Cs,Ar
11	11	12	01	02				11
ij	••	13	01	02				st
11	. 11	14	01	02				98
24	33	11	01	02				Cs,Ar
t t	ii .	12	01	02				19
**	ņ.	13	01	02				ir.
**	"	14	01	02				88
24	34	11	01	02				Cs,Ar
10	19	12	01	02				11
*0	**	13	01	02				tt
À	ů	14	01	02				***
24	4 x	1 X	Not A	pplical	ble			•
30	41	11	01	05	07	09	11	T1,Ar,Pc,Tc,Pl
19	**	12	01	05	07	09	11	98 88 98 80
10	ii	13	01	05	07	09	11	19 80 88 80
•9	ņ	14	01	05	07	09	11	88 88 88 88
30	42	11	01	09	11			Tl,Ar,Tc
10	n	12	01	09	11			n n
10	ii.	13	01	09				ny m is
10	ù	14	01	09	11			96 88 38
30	43	11	01	05	07			Ar,Pc,Pl
5.0	11	12	01	05	07			75 78 88
12	!! !!	13	01	05	07			50 55 55 50 55 55
#2 •	ii	14	01	05	07			59 85 88
30	44	11	01					År
11	11	12	01					88
13	31	13	01					8 u
19	11	14	01					8 u • •
								•

	R. E.			S	EF			
Macro	Micro	Status				ODE		
31	11	11	03	10				Th , Fd
**	11	12	03	04	08	10		Th,Ri,Im,Fd
ii.	11	13	03	04	08	10		" " ,Fd
ii	ů	14	03	04	08	10		" " ,Fd
31	12	11	10	. ,	-			Th .
n	11	12	04	10				Th, im
11	ii.	13	04	10				11 11
ij	ij	14	04	10				n n
31	13	11	10					Th
11	12	12	10					Th
**	ij	13	10					Th
	ij	14	10					Th
	<u>.</u>	• •						
31	14 n	11	-					-
		12	-					•
99	99 19	13 14	-					-
		14	-					•
31	21	11	01	10				Th,Ar
11	11	12	01	04	08	10		Th, Ar, Ri, Im
H	ù	13	01	04	08	10		10 10 11
11	ņ	14	01	04	08	10		11 11 11 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1
31	22	11	01	10		-		Th,Ar
11	11	12	01	04	10			Th,Ar,Im
11	**	13	01	04	10			tt 11 H
, 17 19	ij	14	01	04	10			tt 11 tt
31	23	11	01	10				Th ,Ar
14 2.T	23 11	12	01	10				H H
'11	**	13	01	10				n`
ņ	ń	14	01	10				· ·
		11	01					, A
31 "	24	11	01					Ar
	ii ii	12	01					11
!! !!	ú	13 14	01 01					ii ii
31	3X	1 x		Appli	cable	:		
31	4 x	1 X	Not	Appli	cable	ı		
32	11	11	03	09	10			ጥክ ጥል የታ
11	"	12	03	04	08	09	10	Th,Tc,Fd
11	91	13	03	04	08	09	10	Ri,Th,Tc,Fd,Im Ri,Th,Tc,Fd,Im
•	ii.	14	03	04	08	09	10	Ri,Th,Tc,Fd,Im
•	•	47	0.5	U 4	90	UJ	ΤÅ	ne janjao jeu jam
•	•							

								*
Macro	Micro	Status				CODE		
32	12	11	03	09	10	•		Th,Tc,Fd
n	"	12	03	04	09	10		Th,Tc,Fd,Im
10	ij	13	03	04	09	10		Th,Tc,Fd,Im
11	ń	14	03	04	09	10		
•		14	03	,04	09	10		Th,Tc,Fd,Im
32	13	11	09	10				Th,Tc
18	11	12	09	10				-
91	**	13	09	10				·
ņ	ij.	14	09	10				
:	:.							
32	14	11	-					-
**	11	12	-					•
?	11	13	-					•
ti ,	ii	14	-					4
32	21	11	01	09	10			Th,Tc,Ar
11	n	12	01	04	08	09	10	Th,Tc,Ar,Ri,Im
96	ii ii	13	01	04	08	09	10	H H H H H
, H	n	14	01	04	08 08	09	10	fa fa 19 17 18
•		14	01	04	00	09	10	
32	22	11	01	10			•	Th,Ar
ij	11	12	01	04	10			Th, Ar, Im
11	ij	13	01	04	10			11 11 11
ņ	n	14	01	04	10			ii ii ii
				• •				_ : .
32 **	23	11	01	10				Th,Ar
		12	01	10				
**	"	13	01	10			•	
ij	i	14	01	10				••
32	24	11	01					Ar
11	ii.	12	01					11
ņ	11	13	01					ij.
ņ	in .	14	01					
, 20	2 v	1 🕏	Wa t	'A14-	oblo			•
32	3 X	1%	NOL	Applic	TOTE			
32	4 X	1 x	Not	Applic	able			
33	11.	11	02	03	10			Th, Fd, Cs
n	99	12	02	03	04	08	10	" & Im & Ri
ņ	11	13	02	03	04	08	10	86 p.m. 19 89
**	•	14	02	03	04	08	10	11 11 17 11
<u>:</u> _		• •	~ ~			-		•
33	12	11	02	03	10	_		Th,Cs,Fd
Ħ	••	12	02	03	04	10		" " & Im, Fd
i.	"	13	02	03	04	10		11 11 10 11 10 11
ú	n	14	02	03	04	10		19 19 19

-	R. E.				SEF		.,	1944 Physician (1944) 1944 (1944) 1944 (1944) 1944 (1944) 1944 (1944) 1944 (1944) 1944 (1944) 1944 (1944) 1944
Macro	Micro	Status			CODE			
33	13	11	02	10	•			Th,Cs
ti	н	12	02	10				31 31
ij	ii	13	02	10				ii ii
ti ,	ij	14	02	10				11 11
33	14	11	02					Cs
10	11	12	02					11
19	**	13	02					Ħ
8 2	ij	14	02					11
33	21	11	ó1	02	10			Th,Cs,Ar,
11	19	12	01	02	04	08	10	Th,Cs,Ar,Im,Ri
17	**	13	01	02	04	08	10	11 11 11 11
ň	ú	14	01	02	04	08	10	11 ji 11 ji 11
33	22	11	01	02	10			Th,Cs,Ar
11	11	12	01	02	04	10		rr 10 tr ,Im
ij	ii	13	01	02	04	10		i i i i
ij	ij	14	01	02	04	10		n n n n
33	23	11	01	02	10			Th,Cs,Ar
11	11	12	01	02	10			11 11 11
11	"	13	01	02	10			11 11
ij	H	14	01	02	10			11 11
33	24	11	01	02				Cs,Ar
11	11	12	01	02				n n
ii	ij	13	01	02				11 11
11	ij	14	01	02				11 11
33	3 X	1 X	Not	Appli	c a ble			
33	4 X	1X	Not	Appli	cable	•		
34	11	11	02	03	10			Th,Cs,Fd,Im
**	11	12	02	03	04	08	10	Th, Cs, Ri, Im, Fd
ii	ii	13	02	03	04	08	10	11 11 11 11 11
11	**	14	02	03	04	08	10	i i i ii n
34	12	11	02	03	10			Th,Cs,Fd
• 11	11	12	02	03	04	10		Th,Cs,Fd,Im
**	•	13	02	03	04	10		Th,Cs,Fd,Im
i,	ii	14	02	.03	04	10		Th,Cs,Fd,Im
34	13	11	02	10				Th,Cs
Ħ	**	12	02	10				Th,Cs
ii.	ij	13	02	10				Th,Cs
ii.	"	14	02	10				Th,Cs
								and the state of t

	R. E.				SEF	,		
Macro	Micro	Status			COD	E,		
34 ** **	14 ** ** **	11 12 13 14	02 02 02 02					Ca 10 10 17
34 20 10	21	11 12 13 14	01 01 01	02 02 02 02	1.0 04 04 04	08 08 08	10 10 10	Ar, Th, Cs 11 19 19 , Ri, Im 10 60 00 00 12 00 00 19
34 90 88 90	22 u	11 12 13 14	01 01 01 01	02 02 02 02	10 04 04 04	10 10 10		Ar, Th, Cs 17 10 00 , Lm 17 10 15 10
34 12 11	23	11 12 13 14	01 01 01 01	02 02 02 02	10 10 10			Ar, Th, Cs
34 n !!	24	11 12 13 14	01 01 01 01	02 02 02 02				Ar ,Cs
3.4 10 11	31	11 12 13 14	01 01 01 01	02 02 02 02	10 04 04 04	08 08 08	10 10 10	Ar, Th, Cs 19 11 17, Ri, Im 19 11 17 00 11
34 09 50 50	32	11 12 13 14	01 01 01	02 02 02 02	10 04 04 04	10 10 10		Ar, Th, Cs ** & Im ** **
34 99 99	33	11 12 13 14	01 01 01 01	02 02 02 02	10 10 10			Ar,Th,Cs
34 ** **	34 "	11 12 13 14	01 01 01 01	02 02 02 02				Ar , Cs
34	4 X	1.X	Not	App1:	icabl	æ		

Catalog B

Contains entries relating 2-SEF, 1-SUP, and their effects. Each entry is an 8-digit decimal number, according to the following code:

1st 2 digits - 1st SEF)
2nd 2 digits - 2nd SEF)
3rd 2 digits - SUP)
4th 2 digits - Effects)

Example:

Th and Im have ID effect on STR state.

Coded - 04 10 07 03

Im Th STR ID

Note: Lowest numbered SEF must be placed first, as below - not 10040703, which is not included in the table. (Arrangement of symbols is alphabetic).

SEF	CODE
Ar.	01.
Cs	02
Fd	03
Im	04
Tc	05
Ph	06
P-L	07
Ri	08
Ic	09
Th	10
TI.	11
Zt	12
SUP	CODE
CHEM	01.
CLN	02
ELAS	03
EM	04
RHEO	05
STN	06
STR	07
THER	08
EFFECT	CODE
0	01
I2	02
ID	03
D ²	04

SEF-SUP-EFF TO DIGITAL REPRESENTATION

SEF ₁	SEF ₂	SUP	EFF		DIG	ITAL	REPRES	ENTATION
Ar	Ar	CHEM	0	(01	01	01	01
10	10	CLN	0		01	01	02	01
19	ii.	ELAS	0		01	01	03	01
**	ij	EM	Ō		01	01	04	01
ù	Ħ	RHEO	O		01	01	05	01
ii.	Ħ	STN	Ò		01	01	06	01
u ,	ii ii	STR	Ò		01	01	07	01
# #	ń	THER	0	(01	01	08	01
Ar	Cs	CHEM	0	(01	02	01	01
10	Ħ	CLN	0		ı	11	02	01
, 11	ii	ELAS	0	•	•	11	03	01
11	Ħ	EM	0 1 ²			10	0 4	02
**	11	RHEO	0	•	•	11	0 5	01
15	ņ !!	STN	0 12	•	•	. 64	06	02
11 11 15 17	**	STR	0_			"	07	01
ù	11	THER	012			ij	08	02
Àr	Fd	CHEM	ò		01	03	01	01
16	10	CLN	O.	•	•	tt	02	01
ň	ù	ELAS	Ò	,	1	99	Ó3	01
. "	n.	EM	ID	•	1	ij	Õ4	ġ3
11)1	RHEO	Ò.	•	•	**	05	01
11 10 11 11	11 14 	STN	ID	•	*	11	06	03
ij	Ħ.	STR	o IŽ			ii.	07	01
ņ	i.	THER	12 @	1	<u>!</u>	i	08	02
År	Im	CHEM	O		01	04	01	01
96	n	CLN	0	•	•	11	02	Ol
**	ù	ELAS	^	•	•	30	03	01
ñ.	"	EM	12 &	•	•	ij	04	02
96 7 90 0 90 1 90 1 90	10	RHEO	0	•	•	10	05	01
6 0	ii	STN	10 12		•	ri.	06	03
ń	ņ	STR	I ²	•		ii it	07	02
99	ii.	THER	12	•		it	08	02
År	Pc	CHEM	O	Ċ)1	05	01	01
11	**	CLN	O,	•	0	n	02	01
ń	Ħ.	ELAS	Ó_		•	8.0	03	Õ1
ù	Ņ	EM	0 12	•	•	10	04	02
,	W.	RHEO	0 D2	•	•	**	05	01
ij	Ņ	STN	$\mathbf{p^2}$	•	•	19	06	04
69	# # # #	STR		9 9 9	•	10	07	01
ù	Ä	THER	0 12	*		10	08	02

SEF ₁	SEF ₂	SUP	EFF	DIG	TAL	REPRES	REPRESENTATION		
	Th	CHPM		01	06	01	01		
Ar H	Ph "	CHEM	0 0	14	11	02	01		
		CLN ELAS	0	ņ	ij	03	01 01		
**	11		0		11	03 04	02		
- 1	# •	EM	12 0 D2		**	05			
7	M.	RHEO	02		;;		01 04		
	ii.	STN	9- -2	**	ii	06			
19 19 19 	11	STR	12 12	18	19	07	02		
• • • • • • • • • • • • • • • • • • • •	ij	THER	1~			08	02		
År	P1	CHEM	0	01	07	01	01		
H	11	CLN	Ö	10	11	02	01		
**	'n	ELAS	٥	ň	11	03	01		
ņ	11	EM	12	11	**	04	02		
H		RHEO	ō	11	**	05	01		
ii ii	19 11	STN	0 D2.	ij	n	. 06	04		
,	i,	STR	~ 2	**	11	07	02		
tt :	ń	THER	12	10 12 10 10 10 10	ij	08	02		
Ar	Ri	CHEM	ó	01	08	01	01		
18	M	CLN	ō	11	99	02	01		
ii	Ħ.	ELAS	Ö	ij	ņ	03	01		
**	ij	EM	ĬD	й П	**	04	03		
'n	ii.	RHEO	0.	12	11	05	01		
ii ii	10	STN	0	ń	13	06	01		
• • • • • • • • • • • • • • • • • • • •	ii.	STR	12	38.	н	07	02		
ii.	"	THER	Ī ²	ů	Ħ	08	02		
Ar	Tc	CHEM	0	01	09	01	01		
17	n	CLN	Ö	"	11	02	01		
m	98	ELAS	ŏ	11	19	63	01		
ņ	11	EM	ŏ	18 14	**	04	01		
ņ	•	RHEO	Õ	18	11	05	01 -		
	ij	STN	0 D ²	te	Ħ	06	04		
H H	ņ	STR	12	ņ	**	07	02		
ii.	ú	THER	ID	19	ņ	08	03		
	•	*		•	:	_			
Ar	Th	CHEM	0	01	10		01		
M	•• ,	CLN	0	**	11	02	01		
Ħ.	**	ELAS	o 12	**	*	03	01		
# # !!	ii.	EM		99 99 19 19	**	04	02		
÷.	ii ii	rheo	0	ii.	17	Q 5	Ó1		
ij.	**	STN	ID	ń	ij	06	ộ3		
11	,	STR	ID	Ħ.	18	Ó7	Q3		
Ņ	11	THER	ID	**	*	Ó8	03		

•	SEF ₁	SEF ₂	SUP	EFF	DIG	ITAL	REPRES	ENTATION
	Ar		CHEM	0	01.	11	01	01
•	tt	**	CLN	0	11	11	02	01
	ú	ij	ELAS	0	10	ij	03	01
	ii.	**	EM	0	i	11	04	
	ù	11	RHEO	Ö	i	ij	05	01 01
•	**	**	STN	ID	ņ	ij.		01
	ů.	99	STR	ID	ņ	ń	06	03
	ú	n	THER	ID	ij	iţ	07 08	03 03
	Ar	Zt	CHEM	0	01	12	01	01
	11	10	CLN	Ŏ	11	11		
	11	**	ELAS	Ö	11	11	02	01
	11	H	EM	Ö		•	03	01
	98	ņ	RHEO	0	**	12	04	01
		ņ	STN	ID	10 10 10 10 10		05	01
		11	STR	I ^D		8 8	06	03
	ņ	ii.	THER	0	"	tt	07 08	02 01
	Cs	Cs	CHEM	0	02	02	01	Ö1
	11	11	CLN	12	11	11	02	02
	**	11	ELAS	Ō	••	ii	03	01
	!!	11	EM	Ö	•	it	03	
	11	H	RHEO	ŏ	ij	ù		01
	19	ņ	STN	Ö		11	05	01
	ii.	19	STR	0	11 11	н	06	01
	tr	ņ	THER	ō	ů	ij	07 08	01 01
	~ . Cs	Fd	CHEM	ID	02	03	Ol	03
	11	10	CLN	0	11	11	02	01
	**		ELAS	ŏ	Ħ	E	03	Ŏ1
	ii.		EM	ID	i	i	03 04	03
	11	11	RHEO	0	ir	ņ	05	
	10	11	STN	Ö	· ·	ij	06	01
	ij	11	STR	ō	ij	ij.	07	01
	i.	**	THER	12	** **	ij	08	01 02
	Cs	Ima	CHEM	0	02	04	01	Ó1
	**	11	CLN	ID	11	11	02	03
	ů	11	ELAS		ij	ij	03	
	ii.	ij	EM	0 1	÷		03 04	01
	ii	19	RHEO		ii	11		02
	ņ	ņ	STN	0	# #	n	05	02
	ij	**	STR	12	ij	11	06	01
	ņ	'n	THER	12	i i	" !!	07	02
			LHER		**	"	08	02

 \mathcal{E}_{j}

¥ *	SEF ₁	SEF ₂	SUP	EFF			REPRES	entation
•	Ar	7	CHEM	0	01.	11	01	01
•	11	**	CLN	0	11	H	02	01
	ii.	ij	ELAS	0	Ĥ	11	03	01
	ţţ	W	EM	Ö	i	11	04	01
	19 19	ij	RHEO	Ö	11	ij	05	01
		ņ	STN	ID		ij	06	
	ij	11	STR	ID	**	ij		03
	ú	ņ	THER	ID	ii	11	07 08	03 03
	Ar	Zt	CHEM	0			01	
	11	n	CLN	0	01	12	01	01
	Ħ	ii.	ELAS	0			02	01
	Ħ	•	elas Em		**	!!	03	01
		11		0	# ::	"	04	01
	# !!	**	RHEO	0	**	**	05	01
	ņ	11	STN	ID	tt 	ii.	06	03
	99	!!	STR	12	# #	11	07	02
			THER	0	ii.	ij	08	01
•	Cs	Cs	CHEM	0 12	02	02	01	01
•	81	11	CLN	r ²	tt	Ħ	02	02
	ii.	11	ELAS	0	11	11	03	01
	••	ij.	EM	0	17	11	04	Ŏ1
	**	**	RHEO	0	ņ	11	05	01
	ii	**	STN	0	it	ņ	06	01
	**	11	STR	0	i	ri .	07	01
•	ii	û	THER	0	ij	ij	08	01
	Cs	Fd	CHEM	ID	02	03	01	02
	**	11	CLN	ō	11	11	01	03
	ij	ij	ELAS	Ö	ij	n	02	01
	ņ	i	EM	ID	11	7	03	01
	18	18 •	RHEO		;; tt	•	04	03
	ņ	11	STN	0.	"	 !!	05	01
•	••	ij		0	•	ii.	06	01
	ņ	**	STR	0 1 ²	1† •	"	07	01
			THER		•	ù	08	02
	Cs	Im	CHEM	O	02	04	01	Ó1
	11	11	CLN	ID	11	11	02	03
	11	**	ELAS	0 12	"	tt .	03	01
	# !!	•	em	I.	'n	14	04	02
	ii.	ii	RHEO	12		tt	05	02
	ņ	ij	STN			ń	06	01
	ú	ii.	STR	0 12		i.	07	02
	ù	ij	THER	12		•	08	
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SEF ₁	SEF ₂	SUP	eff	DIG	GITAL	REPRESE	NOITATE
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Cs	Pc	CHEM	0	02	05	01	01
**		CLN	0	11	**	02	01
**	**	elas	0		H	03	01
ù	ü	EM	12	11	**	04	02
ù	ii	RHEO	0	11 11 11	••	05	01
ii ii	11	STN	0	*!	11	06	01
	ij	STR	0 12	ņ	11	07	01
. #	ii	THER	12	ii	"	80	02
Cs	Ph.	CHEM	ID	02	06	01	03
11	u	CLN	ID I ²	11	11	02	02
11	ij	ELAS	0 12 12	***	11	03	Ó1
ij	11	EM	12	11	11	04	Q2
ii.	ii.	RHEO	12	19	ij	05	02
**	11	STN	ō	11	11	06	01
11	10	STR	0 12	ii 11	ij	07	02
# !!	ij	THER	12	11	n	08	02
•	•_			•	•		
Cs		CHEM	ID I ²	02	07	01	03
Ħ	11	CLN	IZ	11	11	02	02
ü	ij	ELAS	0 12	ii.	ù	03	01
ij	**	EM	12	Ħ.	ij	04	02
ij	ii ii	RHEO	0	!! !! !! !!	**	05	01
*!	ij	STN	0 12	ii.	11	06	01
ij	11	STR	12		11	07	02
ņ	!!	THER	<u> </u> 12	ń	ii	08	02
Ċ.	R1	CHEM	İD	02	08	01	03
11	n	CLN	0	19	11	02	01
ņ	ů	ELAS	0	ù	**	03	01
10	**	EM		11	19	04	03
!! !! !!	n	RHEO	ID 12	# # ** ** **	**	05	02
11	ii ii	STN		· ·	11	06	01
11	11	STR	0 12	11	11	07	02
**	ij	THER	12	ņ	ij	08	02
	•		•	* _			
Cs.	Tc	CHEM	ID	02	09	01	03
11	**	CLN	0,	**	**	02	01
24	**	ELAS	0	3.0	11	03	01
10	ņ	em	0	17 10 10 11	13	04	01
ņ	#	RHEO	0	ii	ij	05	01
11	ij	STN	0_	ii	"	06	01
11	ii	STR	0 12	ú	11	07	02
ņ	ii	THER	ID	11	**	08	Q3

SEF ₁	SEF ₂	SUP	EFF	DIG	ITAL	REPRES	ENTATION
Cs	Th	CHEM	ΙĐ	02	10	01	03
11	11	CLN	ID I ²	11	11	02	02
it.	ij	ELAS	0	ii.	11	03	01
"	ii	em	0 I ²	11	ņ	04	02
ij	tt.	RHEO	ID	ij	**	05	03
ù	i.	STN	0.	•• ••	11	06	01
11	11	STR	ID	ii ii	ú	07	03
ù	ù	THER	ID	tī !!	ij	08	03
Cs	71	СНЕМ	ID I ²	02	11	01	03
11	11	CLN	12	11	н	02	02
**	**	ELAS	Q	ii ii	ii.	03	01
11	ii	EM	0	ij	17	04	Õ1
tt.	**	RHEO	ID	'n	19	05	03
ii	11	STN	0		11	06	01
ii	ii	STR	ID	ų	!! !!	07	03
11	ii	THER	ĨĎ	ij	ij	08	03
C.	Zt	CHEM	ID	02	12	01	Ó3
**	11	CLN	0.	Ħ	**	02	01
ij	ij	ELAS	0	"	11	03	01
11	ij	EM	0 12	17 23 18 18 17 17	11	04	01
11	11	RHEO	12	ij	11	05	02
19		STN	0_	11	ij	06	01
H	ij	STR	0 1,2	ų.	ń	07	02
ij	i.	THER	0	11	"	08	01
Fd	F d	CHEM	12	03	03	01	02
Ħ	**	CLN	0	н	n	02	01
ii	**	ELAS		ii,	**	03	01
ii.	ij.	EM	0 D 2	ij	11	04	04
# # # #	ii	RHEO	0	## ## ** ## !!	11	05	01
11	ù	STN	0 12	10	**	06	02
•	**	STR	0	17	**	07	01
ii	ù	THER	12	ii.	·	08	02
F d	Im	CHEM	0	03	04	01	01
Ħ	11	CLN	0	Ħ	n	02	01
11	ij	ELAS	Ō	11	H.	03	01
ij	11	EM	ID	11 11	ij	04	03
ti.	71	RHEO	O	ú	ij	05	01
ti.	tt.	STN	ĭ2	11	ij	06	02
11 te to	11 10	STR		it	"	07	01
11	11	THER	0 1 ²	11	ij	08	02
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sef ₁	SEF ₂	SUP	eff	DIG	ITAL	REPRE	SENTATION
							
Fd	Pc **	CHEM	0	©3	05	01	01
ņ		CLN	o O			02	01
	**	ELAS	<u>o</u>	10 11 10 11 11	19	03	01
7		EM	ID	" "	# #	04	03
90 91 91 	tii 11 10 	RHEO	0.		:	Ó5	01
	7	STN	ID	:	11	06	03
	"	STR	0 <u>1</u> 2	**	ų	07	01 02
	ņ	THER		"		08	02
Fd	Ph.	CHEM	12	03	06	01	Ó2
**	11	CLN	0	96	11	02	01
ii ii	ņ	ELAS	Ö	98 - 97 - 98 - 98 - 98	H	. 03	01
••	ij	EM	ID	i.	**	04	03
Ħ	**	RHEO	Ö.	07	**	05	01
10 10 11 10 10	# # • •	STN	ID	11	#	05 06	03
ņ	ij	STR	0_	**	99	07	01
ú	ù	THER	012	*	ij	08	02
Fd	P1	CHEM	12	03	07	01	02
W	Ħ .	CLN	ō	"	11	02	01
ņ	ņ	ELAS	ŏ	11	1,0	03	01
	ņ	EM	ID	19	**	04	03
11	'n	RHEO	o o	10	10	05	01
19 19 19 11	11 11 20 11	SIN	ID	11 11 11	11	06	03
		STR	0			07	01
		THER	0 12	11		08	02
•	•	IREK				V	02
Fd	Ri	CHEM	1 2	03	08	01	02
n	18	CLN	0	tr	11	02	01
**	99	ELAS	Ö	16	**	03	01
	;; ;;	EM	0 0 D ²		'n	04	04
16 16	11	RHEO	0	ij	11	05	01
16	ii ii	STN	Ō	ij	**	06	01
11	,	STR	00	11 11	99 98 97	07	01
18	n	THER	02	**	11	08	02
	, M.	CHEM	1 ²	03	, 00	01	02
Fd	Tc	CLN		11	09 •	02	01
` <u>`</u>		ELAS	0			03	01
11 - 10 - 10 - 10 - 10 - 10 - 10 - 10 -	91 90 91 90 90 90		0 0	90 90 50	# #	03 04	01
	;; m	EM	0	10	11	04 05	01 01
	;; #	RHEO	O ID			06	03 01
· · · · · · · · · · · · · · · · · · ·		STN			; 80	00 07	03
	.	STR	0.	11 11	11 11	07	01
7	7	THER	ID	"	•	08	Ó3

SEF ₁	SEF ₂	SUP	EFF	DIGI	TAL R	EPRESE	MOITAT
 1							• • • • •
Fd n	Th "	CHEM	12	03	10	01	02
		CLN	0			02	01
11 14	# # # #	ELAS	0	# # !! !!	et • • • • • • • • • • • • • • • • • • •	03	01
77		EM	ID	i	, n	04 05	03
10 10 10 10	**	RHEO	0 12	· · ·	"	05	01
		STN		ņ	ii	06	02
"	!! !!	STR	0	"	ii	07	01
"	ä	THER	ID	, <u>i</u>	ii	08	03
Fd	T.1 .	CHEM	12	03	iı	ő1	02
	E9	CLN	0	11	11	02	Q1
ii	ii	ELAS	0	11	11	03	01
ù	ii	em	0	91	. 11	03 04	01
19 10 10 10 10 10 10 10 10	19 29 29 10 10	RHEO	0.	ii.	11 11 11 11	05	o1
ii.	ij	STN	02	11	11	06	02
ii	ij	STR	0	**	**	07	01
ņ	ii	THER	ID	11 11 • 11 • 11 • 10	**	08	01 03
Fd	Žt	CHEM	12	03	12	01	02
Ħ	11	CLN	ō	11	11	02	01
ii ii	11	ELAS	ŏ	Ĥ		. 02 03	01
99	10 11 10 11	EM	Ö	'n	'n	0/4	01
11 11 11	Ħ	RHEO		•	•	04 05 06 07	01
11	11	STN	0 12	ii	ii	06	02
99	Ħ	STR	Ö	i	11	Ö7	01
10	ij	THER	Ö	69 	11 27 27 27 27 27	08	01
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Im	Im	CHEM	0	04	04	01 02 03 04	01
	**	CLN	D ²	19	Ħ	02	04
•	11	ELAS	I ²	11 18 19	tt.	03	Ô2 O2
	ù	em	I.	ii	**	Õ4	Õ2
ij	!!	RHEO	12	"	**	05	02
**	ij	STN	12	ii	11	06	. 02
10 11 10 10 11 11 11	ii ii	str	D2 12 12 12 12 12 12 12	Ħ .	**	07	02 02
ii,	ů	THER	I ²	Å	00 00 00 00 00 00 00	08	ọ2
Ima	Pc	CHEM	0	04	05	01	01
ii.	H	CLN	0	**	11	02	01
11 11 11	**	ELAS	0	10	11	02 03 04 05 06 07	01
	11	EM	0 12	11	ii	ÔΨ	02
ii.	11	RHEO	ō	•	,	05	01
Ņ	11	STN	ID	ń	**	06	U3 Am
# # • •	11	STR	0	10	ń	07	03 01
19	11 10 10 10 10 10 10	THER	012	#	10 11 10 10 10 10 11	08	02
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SEF ₁	SEF ₂	SUP	EFF	DIG	ITAL	REPRESENTATION		
Im	Ph	CHEM	0	04	96	01	01	
11	••	CLN	ID	99	Ħ	02	03	
**	n	ELAS	0_	ij		03	01	
ii.	!!	EM	0 12 12	**	11	04	02	
ii.	"	RHEO	12	11	tř	05	02	
7\$	19 19 11	STN	ID	11	Ħ	06	03	
tt	13	STR	12	ii.	18	07	Q2	
ii.	ii.	THER	ID 12 12	10 · · · · · · · · · · · · · · · · · · ·	99 29 29 20 20 20 20 20 20 20 20 20 20 20 20 20	08	02	
Im	PŁ	CHEM	0	04	07	01	Õ1	
H LL	80;	CLN	ID	85	72	02	03	
tt.	11	ELAS		11	ù	02 03	01	
**	ii.	em	0 12	11	Ħ	04	ó2	
ii	98	RHEO	0	19	18	05	01	
10 15 17 	98 *8 ** 88 * 89 *	STN	ID	ij	11	<u>0</u> 6	03	
-	ii.	STR	12	19	11	07	02	
ii.	**	THER	ID I ² I ²	17 17 17 18 18 18	11 · 11 · 11 · 11 · 11 · 11 · 11 · 11	<u> </u>	02	
Im	Ri	CHEM	ò	04	08	01	Õ1	
**	**	CLN	0_	11	11	02	01	
ii	11 11 11	ELAS	12	Ħ	ij	03	02	
n	ij	em		11 11 11 11 11	n	04	03	
ņ	ii	RHEO	ID I ²	11	**	05	Õ2	
ų į	n ii	STN	Ω	11	**	06	Ó1	
11	ij	STR	12	**	ù	Õ7	02	
**		THER	12 12	"		08	02	
Im	Tc	CHEM	ó	04	09	01	ò1	
**	tt	CLN	0	11	**	02	01	
**		ELAS	0	ú	ij.	03	Õ1	
"	19	EM	0	11	Ħ	Õ4	Õ1	
,	**	RHEO	0	ń	**	05	Ô1	
•	ii.	STN	ID I ²	11	H	Ó6	Ö3	
# # # # # #	19 99 - 19 09 -	STR	I2	99 99 19 99 90 53	ij	07	ŐŻ	
•		THER	ID		## ## ## ## ##	08	Q3	
Im	Th	CHEM	0	04	10	01	Õ1	
•	**	CLN	ID	18	51	02	03	
ii ii	16 19 19 18	ELAS	ID I ²	60 98 99 99	**	03	03	
ii.	ù	EM	12	**	£9	04	02	
ii.	ù	RHEO	ΙŊ	**	tt.	05	03	
*		STN	ID I	ii.	ņ	06	02	
17 10 10 11	ii.	STR	ID	**	## · · · · · · · · · · · · · · · · · ·	Õ7	03	
i,	tt	THER	ID	ii	i.	08	03	

SEF ₁	SEF ₂	SUP	EFF	DIG	ITAL F	EPRESE	NTATION
Im	71-	CHEM	0	04	11	01	01
**	***	CLN	ID	11	11	02	03
ņ	ii.	ELAS	ID	ů	ń	03	03
"	"	EM	0.	ij	ij	04	01
		RHEO	ID I	ij	11	05	03
# !!	**	STN	IZ		11	06	02
•	11	STR	ID	# #	ti.	07	03
•	ij	THER	ID	ù	11	08	03
Im	Zt	CHEM	O		:		
11	11	CLN	0.	04 #	12	01	01
n	11	ELAS	12	ii ii		02	01
ij	**	EM	ō		"	03	02
Ħ.	ij	RHEO	12	**)t	04	01
11	ij	STN	т2	;; !!	"	05	02
11	ij	STR	12	11 20 11 11 11	17 11 11	06	02
11	Ħ	THER	ō	ij	**	Q7	02
			U		ù	08	01
Pc	Pc	CHEM	0	05	05	à1	
**	11	CLN	Ŏ	•	05	01	01
ij	**	ELAS	Ŏ	11	19	02	01
ii.	i.	EM	Ö	17 10 10 10 10 11 10 10		03 04	01
ii	ņ	RHEO	ŏ		ii ii		01
ii.	ii ii	STN	ō	11	ij	05 06	01
se It	**	STR	Ö	i	ij	07	01
ii) 2	THER	Ö	· ·	ń	08	01 01
Pc	Ph	CHEM	0	05			•
**	11	CLN	o	11	06 ''	01	01
13	ú	ELAS	ő	"	P8:	02	01
H	ù	EM	12	19	_	03	Ó1
ij	11	RHEO	ō	tt	11	Ö4	02
H.	ņ	STN	$\tilde{\mathbf{D}}^2$	'n	99	05	01
11	Ħ.	STR	ō	tt 11 11	**	06	04
ii.	Ħ	THER	12	!!	F. 12	07 08	01 02
<u>:</u>	· -					•	
Pc	P1	CHEM	0	05	07	01	01
11	**	CLN	0	**	13	02	01
**	"	ELAS	0	Ĥ	**	Ö3	Ŏ1
-	**	EM	12	**	ii.	04	02
19	11	RHEO	0	; H	11	05	01
•	# n	STN	D ²	· · · · · ·	"	06	04
11 11	" "	STR	0 I2	ij	## : ## : ## : ## : ## : ## : ## : ##	07	01
7	4	THER	I2	ü	i,	80	02

SEF ₁	SEF ₂	SUP	eff			REPRESENTATION		
Pc	Ri	CHEM	0	 05		01	01	
99	11	CLN	0	10	**	02	01	
n	99 es	ELAS	0	ij	11	03	01	
ii	ij	EM	ID	13 14 17 18 18 18	11	04	03	
14	91. 96 -	RHEO	0.	11	ij	05	01	
**	ij	STN	0	ŧŧ	1t 1f	06	01	
ii	88	STR	0	11	15	Ö7	01	
ij	'n	THER	12	••	II	Õ8	02	
Pc	Tc	CHEM	O	05	09	ò1	Ò1	
Ħ	11	CLN	0	**	**	02	Q1	
99 19	**	ELAS	0	ij	r#	Ó3	Ó1	
19	19	EM	0	tt.	17	Õ4	Õ1	
11 11 11	**	RHEO	0	17	11	05	01	
11	ii	STN	\mathbf{D}^{2}	n u	11	Ò6	04	
ii	11	STR	0		11	07	Ó1	
i,	ù	THER	ID	*	11 11 11 11	Ò8	Õ3	
Pc	Th.	CHEM	0	05	io	01	Õ1	
11	Ħ	CLN	0	**	19	02	01	
**	ii	ELAS	ń	ú	10	03	Õ1	
,	ij	em	12	10	rt.	04	02	
÷.	91	RHEO	0	ij	11	05	Õ1	
# # # * *	11 11	STN	ID	11 11 11	18 10 17 18	06	03	
ii	ii.	STR	0.	Ħ	11	Ò7	01	
	75	THER	ID	ů	₩.	08	03	
Pc	T1	CHEM	0	05	iı	01	01	
**	#	CLN	0	11	19	02	01	
ii.	**	ELAS	0	ü	19	03	01	
# !!	99 11	em	0	ii	99	04	Õ1	
19	11	RHEO	0	**	ii ii	05	Ò1	
ii.	**	STN	ID	H	**	06	03	
ii.	ii	SŢR	0.	n	11 15 19	07	01	
	i,	THER	ID	ù	'n	08	03	
Pc	Zt	CHEM	0	05	12	01	01	
5T	17	CLN	0	11	14	02	01	
19	i.	ELAS	Ō	11	**	03	01	
**	Ħ	EM	0	11	11	04	Ŏ1	
W	tt	RHEO	0	H		05	Õ1	
10	**	STN	ID	**	11	06	Ö3	
¥.	11	STR	0	11 11 12 	10 12 	07	01	
11 11 11 11	N .	THER	. o	11	ų.	08	ŎĪ	
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SEF ₁	SEF ₂	SUP	EFF			EPRESE	NTATION
Ph	"Ph.	CHEM	1 ² 1 ²	06	06	01	02
	**	CLN		##	**	02 -	02
ii ii	11	ELAS	0_	ii	re ·	03	01
" II	**	em	12	ti.	••	04	Ö2
" "		RHEO	12	ii.	11	05	02
" "		STN	$\bar{\mathfrak{D}}^2$	17	11 11 11	06	04
n n	ii ii	STR	12	ú	II	07	02
•	ņ	THER	ī2	ij	Ħ	08	02
Ph	P1	CHEM	0				
n	11	CLN	ŏ	06 "	07 "	01	01
11	11	ELAS	Ö			02	01
11	ii	EM	Ö	 	H	03	01
*	Ĥ	RHEO	Ö	;	**	04	01
11	11	STN	Ö		17	05	01
17	**	STR	Ö		**	Ó6	Õ1
# # # !	ņ	THER	Ö	11 11 11	11	07	Q1
		Time	U	7		Ō8	Õ1
Ph	Ri	CHEM	1 2	06	08	01	Ő2
88	Ħ	CLN	Ō	"	11	02	
##	**	ELAS	Ō	11	İ	03	01
ii	i; # • • •	EM		!! !!	ii	04	01
tt.	**	RHEO	ID I ²	ņ		05	03 02
ii.	*	STN	Ō	it	ii ii	06	01
ù	ii.	STR	0 12	ii	17	07	02
i.	ņ	THER	12	t š	n n	08	02
Ph	Tc	CHEM	12	06	09	Ō1	Ô2
81	11	CLN	0	11	18	02	01
ii t	ņ	ELAS	0	ii.	tř	Ö3	01
	ii	EM	0	n	18 11 10 10	03 04	Ŏ1
	ü	RHEO	0	ij	**	05	01
ņ	**	STN	0 D2	ij	**	06	04
ii.	**	STR	<u>1</u> 2	n ii	•0	07	02
ņ.	••	THER	ID	11	ii.	08	03
Ph	Th	CHEM	12 12	06	10	Ö1	02
**	24	CLN	12	H ·	11	02	02
ii	**	ELAS		**	11	03	02 01
ii ii	Ħ	EM	O 12	į.		04 04	
ii	ů ű	RHEO	ĪD	•0	ii	05	02 03
ú		STN	ID	ii H	11	06	03 03
ù		STR	ID	ņ	ii	07	03 03
i.	i.	THER	ID	'n	# · · · · · · · · · · · · · · · · · · ·	08	03
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SEF ₁	SEF ₂	SUP	EFF	DIC	ITAL	REPRESE	NTATION
Ph	T1	CHEM	12	06	11	01	02
11	11	CLN	1 2	#		02	02
10 70 10 10 10 10 10	ù	ELAS	0	Ħ	n	03	01
	**	em	0	Ħ	•	04	01
	#	RHEO	ID	n	11	05	Ö3
	**	STN	ID	**	**	06	03
	ņ	STR	ID	n	11	07	Ö3
	i	THER	ID	# # # # *	# · · · · · · · · · · · · · · · · · · ·	ŏ8	o3
Ph	Zt	CHEM	í2	06	12	Ó1	ó2
**	11	CLN	0	**	**	02	01
H	17	ELAS	0 -	ij	**	03	ó1
•	ij	em	0 1 2	ú	11	Õ4	Õ1
		RHEO		11	17	05	Õ2
ii ii	10 11 • 11 •	STN	ID I ²	14	11	06	03
	**	STR	12	ņ	10	07	02
***	• #	THER	0 ,	99 	11 11 11 11 11	08	01
Pi	Pi	СНЕМ	12 1	07	07	01	02
80	98	CLN	I ²	11	11	02	02
!!	ii	ELAS	0	ņ	11	03	01
ii.	**	em	0 12	#	18 18 16 11	04	02
tt	ii.	RHEO	O D2		11.	05	01
ii ii	## FE	STN	\mathbf{p}^2	ii.	11	06	04
ii ii	H	STR	12 12	19 10 10	11	07	02
	ù	THER	12	i	iţ	08	Õ2
P1	Ri	CHEM	12	07	08	01	Ò2
	#	CLN	0	**	17	02	01
	**	ELAS	0	n .	Ħ	03	01
Ž	11	em	ID	i.);)) ()	04	03
<u>:</u>	**	RHEO	Ο,	•	**	05	01
	10 10	STN	012	, i	**	06	01
#	**	STR	12	P1 P1 P1 P1 P1 P1 P1 P1	ii.	Θ7	02
	ň	THER	12	Ņ	**	08	02
P1	Tc	CHEM	12	07	09	01	02
	*	CLN	0	11	**	02	01
· ·	**	ELAS	0	ņ	te:	03	01
	17 18	em	0	76 ** **	**	04	Õ1
7		RHEO	0 D 2	, "	**	05	Õ1
110 20 20 100 100 100	•	STN	$\mathbf{D}_{\mathbf{A}}^{\mathbf{Z}}$	n M	ii.	06	04
		STR	I ²	**	818	07	Q 2
ù	÷.	THER	ID	ij	ň	08	03
4							

SEF ₁	SEF ₂	SUP	EFF	DIGI	CAL RE	Presen	TATION
	#. -1		-2	07	10	01	02
P1	"Th	CHEM	1 ² 1 ²	n n	10	02	02
	# ;	CLN	1			03	01
"	ii ii	ELAS	0 12	99 10 10 10 11 11	00 7 80 10 10 11 11	04 04	02
**	;; H	EM	0			05	01
	•	RHEO	ID	i	•	05 06	01 03 03
:	;; #	STN		11	**	07	03
## - ## ## ##	11 11 	STR THER	ID ID	ņ		08 08	03
;		IDEK			•	•	
P1	T1	CHEM	12 12	· 07	11	Ŏ1	02
11	17	CLN	_I 2	Ħ	11	02	02 01
ù	÷	ELAS	0	11	ti.	03	01
Ĥ	14	EM	Ö	ii.	11	04	01
11		RHEO	O	Ħ	ii	05	01
n	H	STN	ID	ij,	**	06	03
H H •	H	STR	ID	te	11 11 - 11 11	07	03
n	10 00 10 10 10 10	THER	ID	ij	i.	08	03
·P1	Zt	CHEM	12	. 07	12	01	02
tt.	n	CLN	ō	, H	tt	02	01
11	19	ELAS		i	18	02 03	01
11 11 11	11 11	EM	0 0 0	11 11	# · · · · · · · · · · · · · · · · · · ·	04	01
'n	i	RHEO	Ô	17	11	Õ5 Õ6	Õ1
**	n	STN	ID	57 17 18	11	Ô6	03
ń	11	STR	1D 12	n	it.	07	02
**	11 17 	THER	0	, 12	ù	08	01
Ri	Ri.	CHEM	12	08	0 8	01	02
11	n	. CLN		11	11	02	01
19 1	ij	ELAS	0 12 D2 12	ņ	11	03	02
ņ	ii	EM	$\bar{\mathbf{p}^2}$	ņ	11 11 11 11 11	04	02 04
ij	# # # #	RHEO	T 2	ú	**	05	02
ņ	'n	STN	Õ	'n	11	06	01
11	11	STR	12	ù	**	07	02
ù H	**	THER	0 12 12	19 · · · · · · · · · · · · · · · · · · ·	,	08	02
Ri	Tc	CHEM	12	08		01	02
II VT	10	CLN	Ō	, 08	#	02	01
	10	ELAS	0	ņ	i.	03	01
# · · · · · · · · · · · · · · · · · · ·	**	EM	0	'n	11	04	01
**	·. 11	RHEO	0	ń		04 05	01
; H		STN	0 12		ń	06	02
11	99 99 10 10 10	STR	0	99 90 1 19 99 99	H ** ** **	07	01
99 99		THER	ID	'n	ij	08	03
7	•	LILLI		•	•	~	70

SEF ₁	SEF ₂	SUP	EFF	DIG	TAL	REPRESEN	TATION
Ri	Th	CHEM	12	08	10	0 01	02
11	***	CLN	0	11	11	02	01
11	.11	ELAS	ID	11		03	03
ij	11	em	ID	11	11	04	03
"	***	RHEO	ID	11	11	05	03
11	11	STN	0		- !!	06	01
tt .	Ħ	STR	ID	ii ii	11	07	03
ij	ü	THER	ID	ů	ü	08	03
Ř1	T1	CHEM	1 2	08	i	01	02
**	**	CLN	0	11	11	02	01
11	**	ELAS	ID	.!!	11	03	03
11	**	EM	0	11 11 11	- 11	04	01
H	ij	RHEO	ID	ij	11	05	03
ij.	1) 11	STN	0	11	11	06	01
ii		STR	ID	18	11	07	03
ij	ņ	THER	ID	!!	"	08	03
Ri	Zt	CHEM	12	08	12	01	02
**	11	CLN	0_	11	11	02	01
	11	ELAS	0 12	11		03	02
ii	!!	EM		11	11	04	01
ii.	ij	RHEO	0 12	11	**	05	02
ii.	ii ii	STN	0	н	11	06	01
**		STR	IZ	11	11	07	02
	ņ	THER	0 1 0	11	ij	08	01
Tc	Tc	CHEM	0	0 9	09	01	01
11	11	CLN	0	u	11	02	01
ņ	ij	ELAS	0	11	11	03	01
ij	11	EM	0	11	11	04	01
11	ij	RHEO	0	11	11	05	01
11	11	STN	0	ij.	ij	06	01
ii.	ij	STR	0	11	**	07	01
11	"	THER	0	. "	11	08	01
Tc	Th	CHEM	1 ²	09	10	01	02
11	11	CLN	0	11	11	02	01
11	ij	ELAS	Ō	**	11	03	01
11	ij	EM	Ō	i i	11	04	01
**	ij	RHEO	Ō	11	ii	05	01
10	"	STN	ID	11	11	06	03
!! !!	ij	STR	ID	!! !!	11	07	03
ų.	ij	THER	$\bar{\mathbf{p}^2}$	į.	ú	08	04
			~	•	•	ĢŪ	•

SEF ₁	SEF ₂	SUP	EFF	DIG	ITAL RE	PRESEN	TATION
Tc	T1	CHEM	12	09	11	01	02
11	99	CLN	ō	11	**	02	01
H H	ii	ELAS	Ö		ņ	03	01
ij	H	EM	ŏ	'n	ú	04	01
ii	ņ	RHEO	Ö	i	'n	05	01
89 97 90	11	STN	ID ,	ii ii	98 18 97	06	03
11	n	STR	ID	ij	¥.	07	03
ů	14	THER	\mathbf{D}^{2}	## # . # . # . # .	19	ọ8	04
Te	Zt	CHEM	12	. 09	12	ó1	02
11	11	CLN	0	11	**	02	01
ii	ii	ELAS	0	ii	"	03	Õ1
ti.	**	em	0	i.	11	04	01
ii	ù	RHEO	0	û	**	05	01
10 17 16 17 18	ii	STN	ID	11 12 - 12 - 11 11	68 10	06	03
ú	ij	STR	12	11	11	07	02
ii.	ù	THER	0			08	01
The	Th	CHEM	12 12 D2 12 D2 12 D2 D2	io	io	01	02
n	H	CLN	IZ	**	17	02	02
rt ·	ii ii	ELAS	\mathfrak{D}_2^2	11 11	11 69 70 10 11 11	03	04
n		em	IŽ	**		04	Q2
H		RHEO	DZ	!!		05	04
ii ii		STN	12	"	"	06	02
	# # #	STR	D2 -2	11 17 	::	07	04
# -		THER	D-	•	"	08	04
Th	71	CHEM	0	10	11	01	01
11	18	CLN	0	11	ŧŧ	02	01
i,	ij	ELAS	0	ú	ri.	Q3	Ò1
**		EM	Ö Ö	•	ù	04	01
ii.	;; ;; ;;	RHEO		11	tt	05	01
ii ii	ij	STN	0	ii	"	06	Q1
ŧi		STR	Ō	•••	ii	07	01
**	ij	THER	Ò		11	80	01
Th	Zt	CHEM	1 ²	io	12	Õl,	Ò2
to .	11	CLN	0	11	11	02	01
ij	**	ELAS	ID	Ħ	**	03	03
11	ij	em	0.	ü	ù	Ö4	01
17	11 11 10	RHEO	TD	11	ú	05	03
**	10	STN	12	**	#	Ó6	02
ni Ni	Ņ	STR	ID	10 11 11 11 10 11		Q7	03
ņ	ij	THER	³ .0.	ii.	11	08	Ó1

SEF ₁	SEF ₂	SUP	EFF			PRESEN	TATION
T1	T1	CHEM	12	11	11	01	02
11	11	CLN	_T 2	W	**	02	02
H	**	ELAS	\bar{D}^2	ń	**	03	04
W.	Ņ	EM	Λ.	ú	**	04	01
11	,	RHEO	D ²	11	11	05	04
**	Ħ	STN	, <u>1</u> 2	ii	17	06	02
11	ù	STR	$\mathbf{p}_{\mathbf{z}}^{2}$	ij	99	07	04
ņ	ù	THER	\mathbf{D}^{2}	ú	ij	08	04
	<u>.</u>		12	•	•		
Tl	Zt	CHEM		11	12	01	02
		CLN	0	51	59	02	01
ii	"	ELAS	ID	ů	to.	Q3	03
**	**	em	O ,	ii.	,	04	01
**	**	RHEO	ID I ²	11	11	05	03
ń.	ii	stn	IZ	ii	ii	06	02
ii.	ii.	STR	ID	**	**	07	03
ii	**	THER	0.	ii	ij	08	01
Zt	Zt.	CHEM	0	12	12	01	01
t†	11	CLN	Ö	11	11	02	01
	tt.	ELAS	Ö	ii.	rr	03	01
11	ti	EM	0	i ti	•	04	01
n	,	RHEO	ŏ	ń	ii	05	01
10	Ħ	STN	Ö	**	•	06	01
H	ij	STR	Ŏ	•	'n	07	01
ņ	17	THER	ö	ii.	ŕ	Õ8	01

VIBRATION AND LOW TEMPERATURE TEST #2

Synchro Type 23TX6

23 Oct 1962

Double Amplitude	0.141 Inches
Variable Frequency	5-60-5 cps
Scanning Time	1 Minute
Direction of Vibration	Vertical
Time Duration	6 Hours
Temperature (Air)	-40°F

	Current	Drawn		_	
	Syı	nchre	Synchro To	emperature ⁰ F	Air Temp OF
Time	#2	#4	#2	#4	oF.
*1000	.23 Amps	.26 Amps	90 ⁰ F	91 °F	69 ° F
1010	.23	. 26	90 ⁰ f	91 0	60°F
1015	•22	.255	76°	71°	20°F
1020	•22	-2 5.	46°	34 [©]	-25°F
1025	.22	•25	25°	18 ⁰	-39°F
1030	•22	•26	110	40	-46°F
1035	.22	•26	50	-3°	-49°F
1040	.22	.26	o°	-1°	-360F
1045	•22	. 26	-3°	-20	-34°F
1055	.2229	•26	-2 °	<u>-3</u> 0	-38°F
1105	. 23	.26	-3°	-3°	-36°F
1200	•23	.265	ەو_	-80	-36°F
1300	•23	_2 6	-10°	-9 [©]	-40°F
1400	•23	. 26	-10°	<u> -90</u>	-41°F
1500	.23	•26	-7°	-6°	-36°F
1610	.23	.26	-13°	-130	-36°F
		24	Oct 1962		
** 0915	•23	.26	84 ° F	86 ⁰ F	

^{*} Before Test
** After Test

ALTITUDE AND LOW TEMPERATURE TEST

Synchro Type 23TX6

17 Aug 1962

Altitude Temperature Time Duration	10,000 -65°F 8 Hour					
Time	Current	Drawn -	MA	Synchro	Temperature	° _F
	#1	.#2	#3	#1	#2	.#3
815	60 ma	76 ma	- 75 ma	54	54	54
8 2 0 .	61 ma	79 ma	76.5 ma	44	44	44
830	64 m#	82 ma	79 mat	24	15	15
840	68 ma	85 ma	83 ma	5	•	•
845	70 ma	87 ma	85 maa	-4	- 5	- 5
900	75 ma	93 ma	89 ma	-19	-24	-23
915	78 ma	96 ma	93 ma	~3 5	∸38	-37
930	80 ma	99 ma	95 🗪	-44	- 47	-47
945	82 ma	101 ma	98 ma	~ 51	- 54	- 53
1000	84 ma	103 m/a	99 ma	-54	- 58	-58
1015	85 ma	104 ma	100 ma	- 58	-60	-60
1030	85 ma	106 ma	100 ma	- 59	- 63	-63
1045	86 mas	106 má	100 ma	-59	-63	-63
*1100	86 ma	40	100 ma	-	-	-
1115	86 ma	106.5 ma	101 ma	-	-	-
1130	86 ma	106 ma	101 ma	•	• *	-
1145	87 ma	106 ma	102 ma	-	•	-
1200	87 🗪	106 ma	102 ma	-	•	-
1300	87 ma	106 ma	102 ma	-59	- 63	-63
	11	11	Ħ	11	18	11
	ii	it .	ii.	Ħ	ii .	. !!
1630	ii.	ii	##	ú	ii.	ii

* Changed Temperature Recorder

Before Test		Current Drawn MA				
Room Temp	74°	#1 .48 ma	#2 .65 ma	#3 .63 ma		
After Test		# 1	# 2	#3		
Room Temp	72°		65 ma			

HIGH TEMPERATURE AND HIGH HUMIDITY TEST #1

Synchro Type 23TX6

Temperature +125°F Humidity 95% RH Time Duration 12 Days

Date	_	Current Drawn - MA Synchro No.			Synchro Temperature Synchro No.	
•	#1	#2	# 3	# 1	#2	#3
Before Test	'50 ma	65 ma	63 ma	73 ⁰ F	73°F	73°F
8/20/62 PM	58-59.5	59 ma	57 ma	124°	1250	124°
8/21/62 AM	58 ma	66 ma	63 ma	125°	124 ⁰	125°
8/21/62 PM	59 ma	67 ma	65 ma	125°	126 ⁰	125°
8/22/62 AM	60 ma	68.8 ma	67 ma	125°	126°	125°
8/22/62 PM	61 ma	68 ma	66 ma	125°	1260	125°
8/23/62 AM	61 ma	68.8 ma	67 ma	1250	125°	125°
8/23/62 PM	61.5 ma	68.8 ma	67 ma	125 ⁰	125°	125°
8/24/62 AM	61.5 ma	69 ma	68.2 ma	125 ⁰	125°	125 ⁰
8/24/62 PM	61.5 ma	69 ma	68.2 ma	125°	125°	125 ⁰
8/27/62 AM	61.5 ma	68.8 ma	68.2 ma	126°	126°	126 ⁰
8/27/62 PM	61.5 ma.	68.8 ma	68.2 ma	126°	126°	126°
8/28/62 AM	61.5 ma	68.8 ma	67 ma	126°	126 ⁰	126 ⁰
8/28/62 PM	61.5 ma	68.8 ma	67 ma	125°	125°	125°
8/29/62 AM	62 ma	69 ma	68.2 ma	125°	126°	125°
8/29/62 PM	62 ma	69 ma	68 ma	125°	126°	125°
8/30/62 AM	62 ma	69 ma	68 ma	126°	126°	125°
8/30/62 PM	62 ma	69 ma	68 ma	126°	126°	125°
8/31/62 AM	62 ma	69 ma	68 ma	1260	125°	125°
8/31/62 PM	62 ma	69 ma	68 ma	1200	120°	1190
After Test	58 ma	66 ma	65 m ±	75°	75°	75°

APPENDIX 8

HIGH TEMPERATURE AND HIGH HUMIDITY TEST #2

Synchro Type 23TX6

Temperature +125°F Humidity 95% RH Time Duration 5 Days

Date	Time	Current Synchr		Synchro '	Temperatures
		#2	#4	#2	#4
10/29/62	820	.26 Amps	.305 Amps	106° p	100°F
81	830	•255	.30	121°	120 ⁰
**	840	•255	.30	126 ⁰	132 °
***	850	•25	•30	126 ⁰	134 ⁰
ņ	900	.2 5	. 30	126 ⁰	136 [®]
ņ	910	.2 5	2 95	128 ⁰	138 ⁰
"	920	•25	.2 95	128°	139 °
ii.	930	.2 5	.30	128°	139°
"	940	. 25	•30	128 ⁰	140 ⁶
÷.	1000	.2 5	.29 5	129°	141 [•]
ņ	1100	•25	. 30	1290	142 [©]
ii.	1200	•25	. 30	129°	144 ⁶
ņ	1300	•25	, 30	1290	144 ⁰
ii	1500	.2 6	•30	1,270	140 ⁹
	1600	•255	. 30	128°	141°
10/30/62	827	•26	•30	126°	135°
tt	930	•26	. 30	127 ⁰	137°
ij	1030	•26	. 30	127°	138 ⁰
Ħ	1130	. 26	•30	127 °	137 <mark>6</mark>
11	1230	•26	•305	126 ⁰	136°
ii.	1330	.26	. 305	127°	137 ⁰
ij	1430	•255	•30	127°	138°
ij	1530	•26	•30	127°	137°
ij	1625	•26	•30	128°	138 ⁰
10/31/62	830	.25 5	. 305	126°	1340
91	930	•26	3 0	127°	136°
10	1130	•26	•30	1270	136 ⁰
11	*1230	•26	032	127°	136°
ij	1345	•26	•30	128 ⁰	140°
11	*1430	.26	033	1270	137°
ų,	1530	•26	•30	127°	137°
n	1630	.255	•305	126°	136°

* 830 940 * 1030 1130 1230	Synchre #2 .25 Amps .25 .25 .25	#4 030 Amps .30 030	# 2 127°F 128° 127°	Temperatures °F #4 136°F 140°
940 * 1030 1130	.25 Amps .25	030 Amps	127°F 128°	136°F 140°
940 * 1030 1130	•25 •25	•30	128 ⁰	140°
* 1030 1130	•25 •25	•30	128 ⁰	140°
* 1030 1130	•25		1070	
1130			A.Z. /	138 ⁰
	~	3 05	127°	138 ⁰
	.2 55	•305	1270	138°
				137°
				137°
		-	1290	138°
1625	.255		129°	138°
845	•255	_30	128°	139°
930		-	128°	139°
			127 ⁰	137 [©]
				139°
			127°	137°
	•25		1270	137°
	•25 ₄ ;		128 ⁰	138 ⁰
1615	,25	•30	128°	1390
830	.2 6	.2 9	83 • 5°	98 ⁰
	845 930 1130 1230 1330 1430 1530 1615	1430 .25 1530 .255 1625 .255 845 .255 930 .25 1130 .255 1230 .255 1330 .25 1430 .25 1530 .254 1615 .25 830 .26	1330 .255 .30 1430 .25 .30 1530 .255 .30 1625 .255 .30 845 .255 .30 930 .25 .30 1130 .255 .305 1230 .255 .305 1330 .25 .30 1430 .25 .30 1530 .254 .30 1615 .25 .30	1330 .255 .30 127° 1430 .25 .30 127° 1530 .255 .30 129° 1625 .255 .30 129° 845 .255 .30 128° 930 .25 .30 128° 1130 .255 .305 127° 1230 .255 .305 128° 1330 .25 .30 127° 1430 .25 .30 127° 1530 .254 .30 128° 1615 .25 .30 128° 830 .26 .29 83.5°

^{*} Synchro No. 4 appears to be stopping and starting.

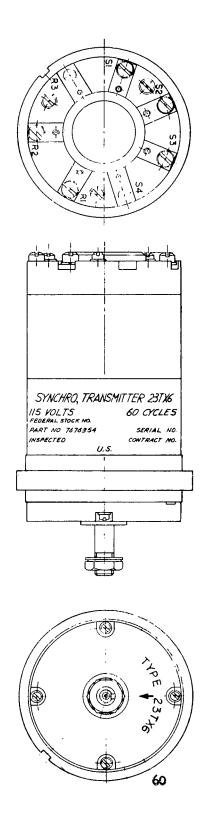


Figure 1. Synchro, Transmitter Type 23TX6 - assembled view

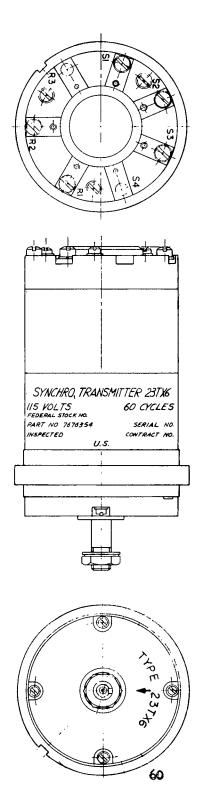


Figure 1. Synchro, Transmitter Type 23TX6 - assembled view

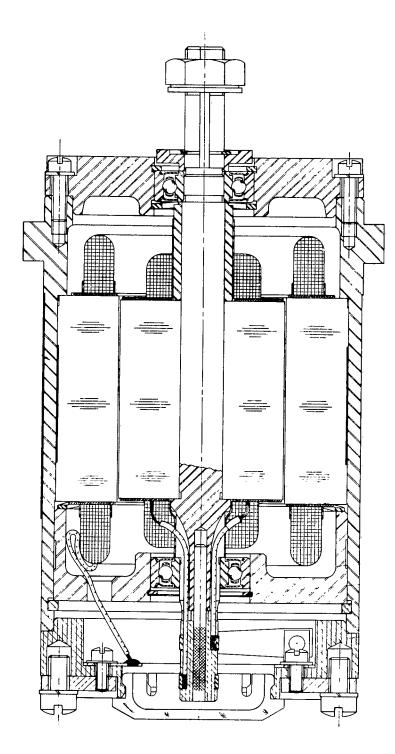
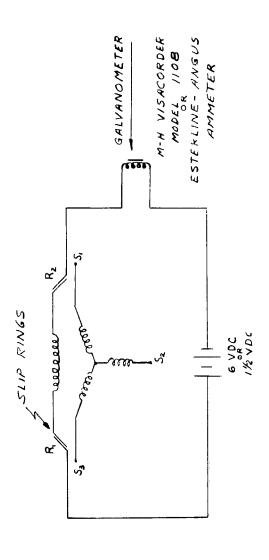


Figure 2. Synchro, Transmitter Type 23TX6 - sectioned view



Figure 3. Typical Test Setup for Vibration and Low Temperature Test



Schematic Diagram for Vibration and Low Temperature Test No. 1 - Synchro Type Altitude and Low Temperature Test No. 1 High Temperature and High Humidity Test No. 1 23TX6 Figure 4.

3.014. 8/10/62

SYNCHRO #1 35 CPS

Vibration and Low Temperature - Test No. 1 Vibration at Ambient Temperature, Arcing at 35 to 60 cps - 10 Aug. 62 Figure 5.

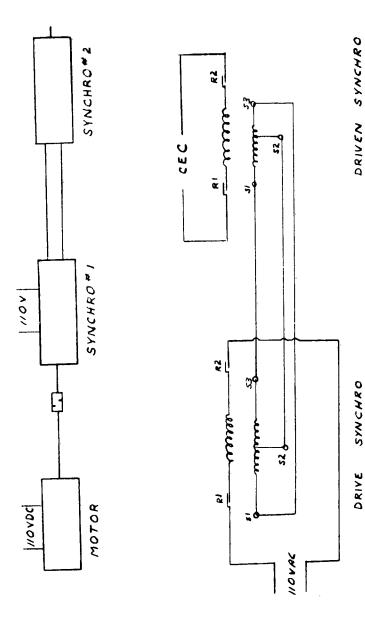
J.O.N. 8/13/62

45 CPS SYNCHRO#1

60 CPS

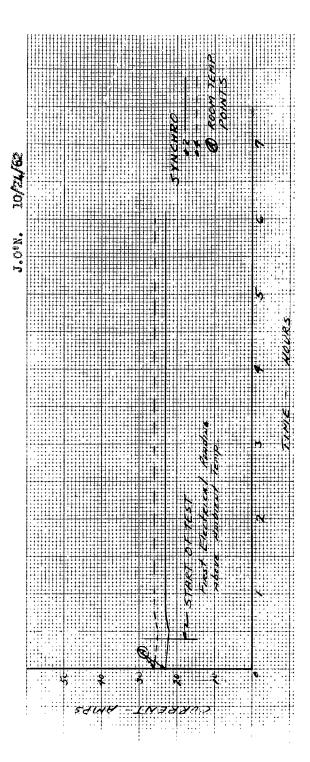
Figure 6. Vibration and Low Temperature - Test No. 1
Vibration at -40°F, 45 to 60 cps - 13 Aug. 62

65



Electrical Setup . Vibration and Low Temperature Test No. 2 High Temperature and High Humidity Test No. 2. Figure 7.

66



Current vs. Time at $-\frac{1}{4}$ 0°F, Double Amplitude 0.1 4 1", Variable Frequency 5-60-5 cps, Vertical Vibration, Time Duration - 6 Hrs., Synchro Type 23TX6 Vibration and Low Temperature Test No. 2 Figure 8.

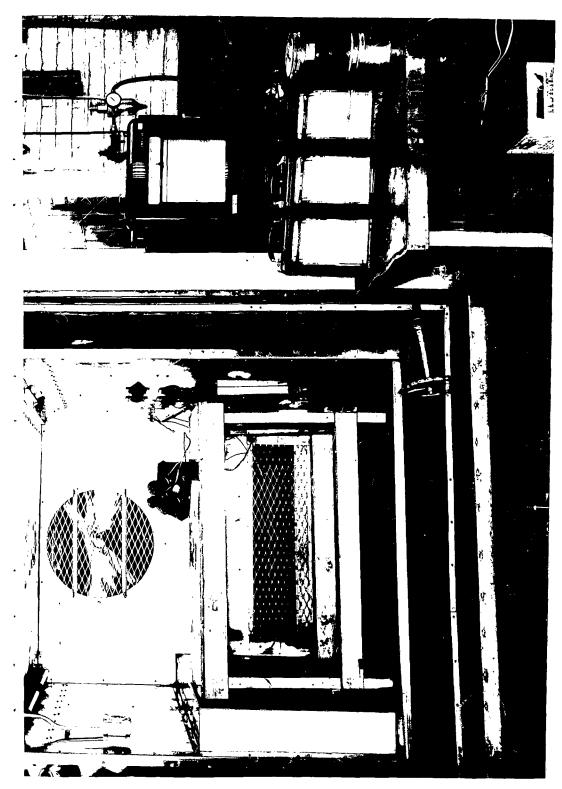
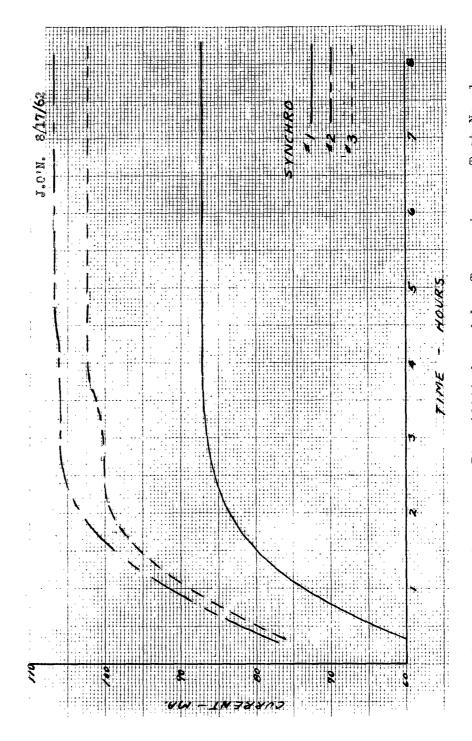
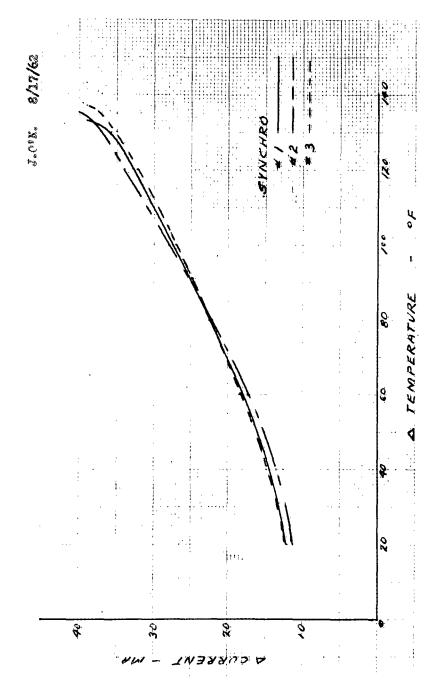


Figure 9. Typical Test Setup for

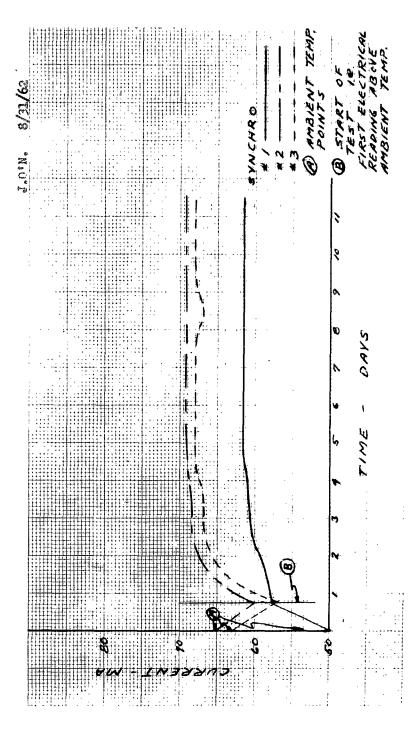
1. Altitude and low temperature test
2. High temperature and humidity test #1



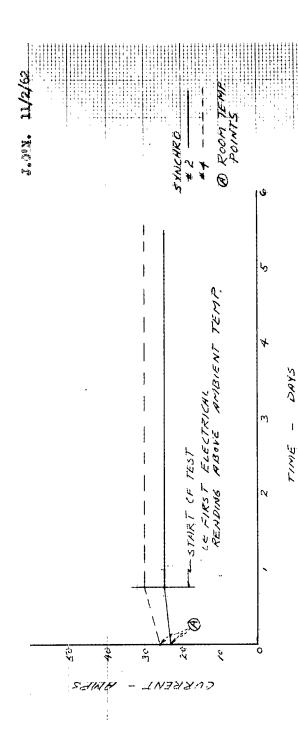
Current vs Time Altitude and Low Temperature - Test No. 1 10,000 Ft., Synchro Type 23Tx6, 8 Hr. Test - 17 Aug. 62 Figure 10.



A Current vs A Temperature Altitude and Low Temperature - Test No. 1 10,000 Ft. - 65°F., Synchros Type 23TX6, 8 Hr. Test Figure 11.



High Temperature and High Humidity Test No. 1 Current vs Time, 125°F - 95% RH, Synchro Type 23TN6 Figure 12.



High Temperature and High Humidity Test No. 2 Current vs Time, 125° F - 95% RH, Synchro Type 23TM6 Figure 13.

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